



**UNESCO sponsored Conference**  
**5<sup>th</sup> DUBROVNIK CONFERENCE ON**  
**SUSTAINABLE DEVELOPMENT**  
**OF ENERGY, WATER AND ENVIRONMENT SYSTEMS**

**BOOK OF ABSTRACTS**

**September 29<sup>th</sup> - October 3<sup>rd</sup> 2009, Dubrovnik,  
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## Conference Venue: Dubrovnik

*"Those who seek paradise on Earth  
should come to Dubrovnik and see Dubrovnik."*

*(George Bernard Shaw)*

Dubrovnik is situated in the southernmost part of the Republic of Croatia. Founded in the 7<sup>th</sup> century, Dubrovnik is rich with cultural and historical monuments and is included in the UNESCO World Heritage list. The city is surrounded with the walls built between the 11<sup>th</sup> and 17<sup>th</sup> century. Its cultural and scientific institutions include Museum at Rector's Palace, Cathedral Treasury, Pinacotheca, Franciscan monastery and cloister, with one of three oldest pharmacies in Europe (14<sup>th</sup> c.), the Cathedral (initial funds given by King Richard the Lionheart), one of the European oldest Synagogues, Marin Drzic Theatre, Dubrovnik Symphony Orchestra, Interuniversity Center. Nature lovers can find here true Mediterranean landscape, and "enjoy the cleanest sea in the Mediterranean" (Jean Jacques Cousteau). Dubrovnik International Airport is situated 22 km from the city center.





## Scope and Objectives

*"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

*The Report of the U.N. Brundtland Commission, Our Common Future, 1987*

The Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems, to be held in 2009 for its 5<sup>th</sup> consecutive time, is dedicated to the improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development, taking into account its economic, environmental and social pillars, as well as methods for assessing and measuring sustainability of development, regarding energy, transport, water and environment systems and their many combinations. Sustainability being also a perfect field for interdisciplinary and multi-cultural evaluation of complex system, the Dubrovnik Conference has during the first decade of the 21<sup>st</sup> century become a significant venue for researchers in those areas to meet, and discuss, share, and disseminate new ideas.

*"Then I say the earth belongs to each of these generations during it's course, fully, and in their own right. The 2<sup>nd</sup>. generation receives it clear of the debts and incumbrances of the 1<sup>st</sup>., the 3<sup>rd</sup>. of the 2<sup>nd</sup>. and so on. For if the 1<sup>st</sup>. could charge it with a debt, then the earth would belong to the dead and not the living generation. Then no generation can contract debts greater than may be paid during the course of it's own existence."*

*Thomas Jefferson, Sept.6, 1789*

The scope of the Conference will continue to successfully cover the following areas (with examples in parentheses, but not confined to these examples only):

- Sustainability comparisons and measurements methodologies (metrics and indices, multi-criteria analysis, external costs, exergy analysis, footprint methods, emergy)
- Energy policy (security of supply, climate change mitigation, renewable energy support schemes, energy efficiency, employment generating, agriculture and forestry, tax, cap and trade, feed-in, green certificates)
- Transport policy (urban sprawl management, traffic management, road pricing, modal management, alternative fuels, social aspects, rail vs. air)
- Water policy (water management, wastewater management, water reuse, water pricing)
- Environmental policy (waste management, wastewater management, climate change, air pollution policy, water pollution policy, land management, biomass management, social aspects, emission tax, cap and trade)

- Energy system analysis (Energy system analysis models, tools and methodologies, Energy system analysis surveys and results)
- Life cycle assessment, Environmental impact assessment, Eco-design and Eco-labelling
- Energy planning (power system planning, smart energy networks, natural gas system planning, high penetration of renewables, island energy systems, development of energy planning tools, internalizing environmental externalities)
- Transport management (modelling, optimisation, tracking, GPS/mobile systems)
- Renewable energy resources (forest and agricultural biomass, biofuels, biogas, hydro, wind, solar, geothermal, wave and ocean)
- Primary energy resources (oil, gas, coal, uranium, thorium, oil peaking)
- Water resources (surface, ground, desalination, etc.)
- Food and agriculture
- Renewable electricity generation systems (biomass, grid and fluidized bed, biofuels, biogas, hydro, wind, photovoltaic, concentrated solar thermal power, geothermal, wave, tide, ocean thermal)
- Thermal power plants (clean coal, fluidized bed, combined cycles)
- Carbon capture and storage/sequestration (oxy-fuel combustion, pre-combustion capture, post-combustion capture, CO<sub>2</sub> transport, enhanced oil/gas recovery, enhanced coal bed methane recovery, aquifer storage, bedrock storage, ocean storage, leakage)
- Nuclear energy (new power plant designs, waste, proliferation, policies, acceptance)
- Advanced sustainable energy conversion systems (fuel cells, thermoelectric, thermionic, organic)
- Renewable heat systems (biomass, biofuels, biogas, solar, geothermal, heat pumps)
- Biofuels and biorefineries (biodiesel, bioethanol, second generation biofuels, anaerobic digestion, BTL, biorefineries, vehicles, infrastructure, combustion modelling, sustainability assessment)
- Hydrogen production technologies (stationary, mobile, small applications, electrolysis, reforming, nuclear hydrogen, infrastructure)
- Hybrid and electric vehicles (first generation, plug in, charging, batteries, infrastructure)
- Other alternative fuels (DME, CNG, LPG, resources, production, vehicles, infrastructure)
- Water treatment (methods, health issues, standards, grey water)
- Desalination (distillation, reverse osmosis, energy recovery, discharge management)
- Wastewater treatment (municipal, industrial, agricultural)
- Waste treatment (composting, incineration, landfill, anaerobic digestion, gasification, mechanical biological treatment, mechanical heat treatment, plasma arc waste disposal, pyrolysis, recycling)
- Waste to energy (incineration, landfill gas capture, RDF, cement industry, tyres, combustion modelling)

- Recycling waste (glass, paper, metals, containers, tyres, textiles, batteries, biodegradable waste, separation, financial schemes)
- Pollution modelling (CFD models, air pollution spreading, water pollution spreading, combustion modelling)
- Heat and mass transfer modelling (CFD models, energy efficiency)
- Cogeneration (heat and power, water and power, biofuels and power, transport and energy, food and energy, waste to energy)
- Trigenation, polygeneration
- Storage (heat storage, hydrogen storage, hydropower as storage, pump storage, compressed air storage, batteries, water storage, biofuels storage, storage optimisation modelling, financial support mechanisms, maximising renewables, optimising load, power market arbitrage, smart energy networks)
- Energy efficiency (industry, agriculture, appliances, smart appliances, load management, rebound effects and mitigation)
- Buildings (passive buildings, smart buildings, green buildings, building standards, heating, ventilation, air-conditioning, cooling, insulation, renewables, heat pumps, load management, storage, sustainable architecture)
- Energy markets (liberalisation, regulation, spot markets, pools, storage, renewables, merging and acquisitions, modelling)
- Emission markets (ETS, carbon, GHG, SO<sub>x</sub>)
- Employment and energy, transport, water and environment systems (technology development, equipment production, installation, maintenance)
- Technology transfer and development (emerging markets, developing countries, least developed countries, new opportunities)
- Social acceptance (reform, NIMBY, nuclear, wind, hydrogen, hidden and special interests)
- Sustainable tourism (energy systems, transport systems, water systems, environment systems, green hotels)
- Urbanism (urban planning, zoning, transport, modal shift)
- Education in Sustainable Development (Governance, Environmental Awareness, Higher Education in SD, Engineering Education in SD)
- Cooperation for Development (International Development Mechanisms, Clean Development Mechanisms, etc.)

## Preface

The purpose of the 5<sup>th</sup> Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES) is to provide a forum for world-wide specialists in the sustainability of development to present progress of researchers, and to discuss the state of the art, the future directions and priorities in the various areas of the sustainability of development: this conference especially in the improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development, taking into account its economic, environmental and social pillars, as well as methods for assessing and measuring sustainability of development, regarding energy, transport, water and environment systems and their many combinations.

It would not have been possible to organise the 5<sup>th</sup> Dubrovnik SDEWES Conference if its participants had not sent over 700 abstracts which are peer-reviewed and nearly 400 papers were accepted and are collected in this Proceedings. The organizers wish to express them their gratitude for having taken interest in the 5<sup>th</sup> Dubrovnik SDEWES Conference and for their invaluable written and oral contributions. We sincerely thank the Members of the International Scientific Committee and the Members of the Scientific Advisory Board who devoted much time for reviewing the abstracts and papers, who contributed to the success of this conference and the quality of Proceedings. We also grateful our Colleagues, the Members of the Organising Committee and to all people who contributed in many ways, for their endeavours in organization of the 5<sup>th</sup> Dubrovnik SDEWES Conference. Special thanks to the invited lecturers.

We would like to welcome all the participants of the 5<sup>th</sup> Dubrovnik SDEWES Conference coming from nearly 60 countries all over the world. We trust that this conference will reach the goal of bringing together scientists and engineers and inspire them to gather more knowledge in order to tackle mankind's future problems. Last but not the least we would be happy if your stay in Dubrovnik would be enjoyable, fruitful, pleasant, happy and sunny, in town which is included in the UNESCO world Heritage list.

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*Chairman of International Scientific Committee*

Prof. Ivo Šlaus  
*Chairman of Scientific Advisory Board*

Prof. Neven Duić  
*Chairman of Local Organising Committee*

Prof. Zvonimir Guzović  
*Conference Secretary*

## Programme

Tuesday, September 29 <sup>th</sup>	
9:00 - 10:00	Registration ( <a href="#">HALL A</a> )
10:00 - 12:30	Excursion to HPP Dubrovnik
12:00 - 13:00	Registration ( <a href="#">HALL A</a> )
13:00 - 15:30	Excursion to HPP Dubrovnik
16:00 - 18:00	Registration ( <a href="#">HALL A</a> )
19:30 - 20:30	Welcome reception
Wednesday, September 30 <sup>th</sup>	
7:30 - 9:30	Registration ( <a href="#">HALL A</a> )
9:30 - 10:30	Opening of the conference ( <a href="#">Room A</a> )
10:30 - 11:30	Key note lecture <b>Prof. Noam Lior:</b> Sustainable Energy Development: the Present (2009) Situation and Possible Paths to the Future ( <a href="#">Room A</a> )
11:30 - 12:00	Coffee break ( <a href="#">HALL B</a> )
12:00 - 13:30	Parallel sessions  <u>Special Session:</u> Sustainability strategies in building sector: life cycle approaches, methods and tools ( <a href="#">Room A</a> ) <i>Chairman: Dr. Mario Tarantini</i> Biomass, Biogas and Biofuels: Potentials and limitations I ( <a href="#">Room B</a> ) Advances in Waste Management I ( <a href="#">Room C</a> ) Developments in Solar Photovoltaic Energy Conversion ( <a href="#">Room D</a> ) Heat and Mass Transfer in Energy and Environment Systems I ( <a href="#">Room E</a> ) Fundamentals of sustainability ( <a href="#">Room F</a> )
13:30 - 14:30	Buffet lunch (HALL B + HALL C)
14:30 - 16:00	Parallel sessions  <u>Special Session:</u> Biofuels sustainability ( <a href="#">Room A</a> ) <i>Chairman: Prof. Viatcheslav Kafarov</i> Towards Sustainable Combustion I ( <a href="#">Room B</a> ) Advances in Waste Management II ( <a href="#">Room C</a> ) Solar Thermal Heat and Power I ( <a href="#">Room D</a> ) Heat and Mass Transfer in Energy and Environment Systems II ( <a href="#">Room E</a> )

	Approaches to Sustainable Development: Methodologies I (Room F)
16:00 - 16:30	Coffee break (HALL B)
16:30 - 18:00	Parallel sessions
	<u>Special Session: Biofuels sustainability</u> (Room A) <i>Chairman: Prof. Viatcheslav Kafarov</i>
	Sustainable Manufacturing and Mining I (Room C)
	Solar Thermal Heat and Power II (Room D)
	Hydro, Wind, Geothermal I (Room E)
	Approaches to Sustainable Development: Methodologies II (Room F)
18:00 - 18:30	Coffee break (HALL B)
18:30 - 20:00	Parallel sessions
	<u>Special Session: Biofuels sustainability</u> (Room A) <i>Chairman: Prof. Viatcheslav Kafarov</i>
	Advances in Waste Management III (Room C)
	Sustainable Transport I (Room D)
	Hydro, Wind, Geothermal II (Room E)
	Approaches to Sustainable Development: Case Studies (Room F)
<b>Thursday, October 1<sup>st</sup></b>	
7:30 - 9:00	Registration (HALL A)
9:00 - 10:00	Key note lecture <b>Prof. Henrik Lund:</b> How to implement Renewable Energy Systems? Lessons learned from the Danish case. (Room A)
10:00 - 11:30	Parallel sessions
	<u>Special Session: On the way to 100% Renewable Energy Systems</u> (Room A) <i>Chairman: Prof. Henrik Lund</i>
	Social Aspects of Sustainable Development (Room B)
	Combined Cycle and Cogeneration Heat and Power Systems I (Room C)
	Measurement and Monitoring for Sustainability I (Room D)
	Sustainable Manufacturing and Mining II (Room E)
	Nuclear Power (Room F)
11:30 - 12:00	Coffee break (HALL B)
12:00 - 13:30	Parallel sessions
	<u>Special Session: On the way to 100% Renewable Energy Systems</u> (Room A) <i>Chairman: Prof. Henrik Lund</i>

	Approaches to Sustainable Water Development: Methodologies (Room B)
	Combined Cycle and Cogeneration Heat and Power Systems II (Room C)
	Sustainable Agriculture (Room D)
	Conservation and Demand-Side Management I (Room E)
	Side Event - BIOSIRE project workshop (Room F)
	<i>Chairman: Prof. Neven Duić</i>
13:30 - 14:30	Buffet lunch (HALL B + HALL C)
14:30 - 16:00	Parallel sessions
	<u>Special Session:</u> Storage Requirements For a 100% Energy Supply (Room A)
	<i>Chairman: Prof. Ingo Stadler</i>
	Approaches to Sustainable Water Development: Case Studies I (Room B)
	Advances in Thermal Power, Heat, and Cooling I (Room C)
	Education and Technology Transfer for Sustainability (Room D)
	Environmental Concerns (Room E)
	Side Event - BIOSIRE project workshop (Room F)
	<i>Chairman: Prof. Neven Duić</i>
16:00 - 16:30	Coffee break (HALL B)
16:30 - 18:00	Parallel sessions
	<u>Special Session:</u> Converting Biomass and Wastes into Green Fuels by Modular Thermochemical systems (Room A)
	<i>Chairman: Prof. Anastasia Zabaniotou</i>
	Approaches to Sustainable Water Development: Case Studies II (Room B)
	Advances in Thermal Power, Heat, and Cooling II (Room C)
	Hydro, Wind, Geothermal III (Room D)
18:00 - 18:30	Coffee break (HALL B)
18:30 - 20:00	<u>Round table</u> "The energy-water interdependence", (Room A)
	<i>Chairman: Prof. Noam Lior</i>
<b>Friday, October 2<sup>nd</sup></b>	
7:30 - 9:00	Registration (HALL A)
9:00 - 10:00	Key note lecture
	<b>Prof. Maria da Graça Carvalho:</b> Building a Low Carbon Society (Room A)
10:00 - 11:30	Parallel sessions

Special Session: Interconnected Crises: Energy, Climate,  
Demography and Economy - New Approaches to Solutions  
(Room A)

*Chairman: Prof. Aleksander Zidanšek*

*Co-chairman: Prof. Ivo Šlaus*

Special Session: Integrating Waste and Renewable Energy to  
reduce the Carbon Footprint of Locally Integrated Energy Sectors  
(Room B)

*Chairman: Prof. Jiri Klemes*

*Co-chairman: Prof. Ferenc Friedler*

Hybrid Renewable Energy Systems (Room C)

Greenhouse Gas Emissions, Impacts and Countermeasures I  
(Room D)

Towards Sustainable Combustion II (Room E)

Side Event - STORIES project workshop (Room F)

*Chairman: Dr. Zoulias*

11:30 - 12:00	Coffee break (HALL B)
12:00 - 13:30	<p>Parallel sessions</p> <p><u>Special Session</u>: Interconnected Crises: Energy, Climate, Demography and Economy - New Approaches to Solutions (Room A)</p> <p><i>Chairman: Prof. Šlaus</i></p> <p><i>Co-chairman: Prof. Zidanšek</i></p> <p><u>Special Session</u>: Integrating Waste and Renewable Energy to reduce the Carbon Footprint of Locally Integrated Energy Sectors (Room B)</p> <p><i>Chairman: Prof. Klemes</i></p> <p><i>Co-chairman: Prof. Friedler</i></p> <p>Sustainable Transport II (Room C)</p> <p>Greenhouse Gas Emissions, Impacts and Countermeasures II (Room D)</p> <p>Hydrogen and Fuel Cells I (Room E)</p> <p>Side Event - STORIES project workshop (Room F)</p> <p><i>Chairman: Dr. Manos Zoulias</i></p>
13:30 - 14:30	Buffet lunch (HALL B + HALL C)
14:30 - 16:00	<p>Parallel sessions</p> <p>Biomass, biogas and biofuels: Conversion Processes I (Room B)</p> <p>Building a research career in the European Research Market: EU institutional and financial tools (Room C)</p> <p>Greenhouse Gas Emissions, Impacts and Countermeasures III (Room D)</p> <p>Hydrogen and Fuel Cells II (Room E)</p>



Side Event - STORIES project workshop ([Room F](#))

*Chairman: Dr. Manos Zoulias*

17:30 - 23:00 Excursion and gala dinner

### Saturday, October 3<sup>rd</sup>

7:30 - 9:00 Registration ([HALL A](#))

9:00 - 10:00 Key note lecture

**Prof. Xiliang Zhang:** Technologies and Policies for the Transition to a Sustainable Energy System in China ([Room A](#))

10:00 - 11:30 Parallel sessions

Special Session: National Strategies for Sustainable Development ([Room A](#))

*Chairman: Prof. Natasa Markovska*

Biomass, Biogas and Biofuels: Potentials and Limitations II ([Room B](#))

Renewable Energy Planning and Implementation I ([Room C](#))

Measurement and Monitoring for Sustainability II ([Room D](#))

Conservation and Demand-Side Management II ([Room E](#))

Sustainability in Buildings I ([Room F](#))

11:30 - 12:00 Coffee break ([HALL B](#))

12:00 - 13:30 Parallel sessions

Special Session: National Strategies for Sustainable Development ([Room A](#))

*Chairman: Prof. Natasa Markovska*

Biomass, Biogas and Biofuels: Potentials and limitations III ([Room B](#))

Renewable Energy Planning and Implementation II ([Room C](#))

Advances in Distribution systems ([Room E](#))

Sustainability in Buildings II ([Room F](#))

13:30 - 14:30 Buffet lunch (HALL B + HALL C)

14:30 - 16:00 Parallel sessions

Special Session: Role and Responsibility of Local Authorities in Assuring Energy Supply and Energy Security for Industry and Population ([Room A](#))

*Chairman: Prof. Milun Babić*

Biomass, biogas and biofuels: Conversion Processes II ([Room B](#))

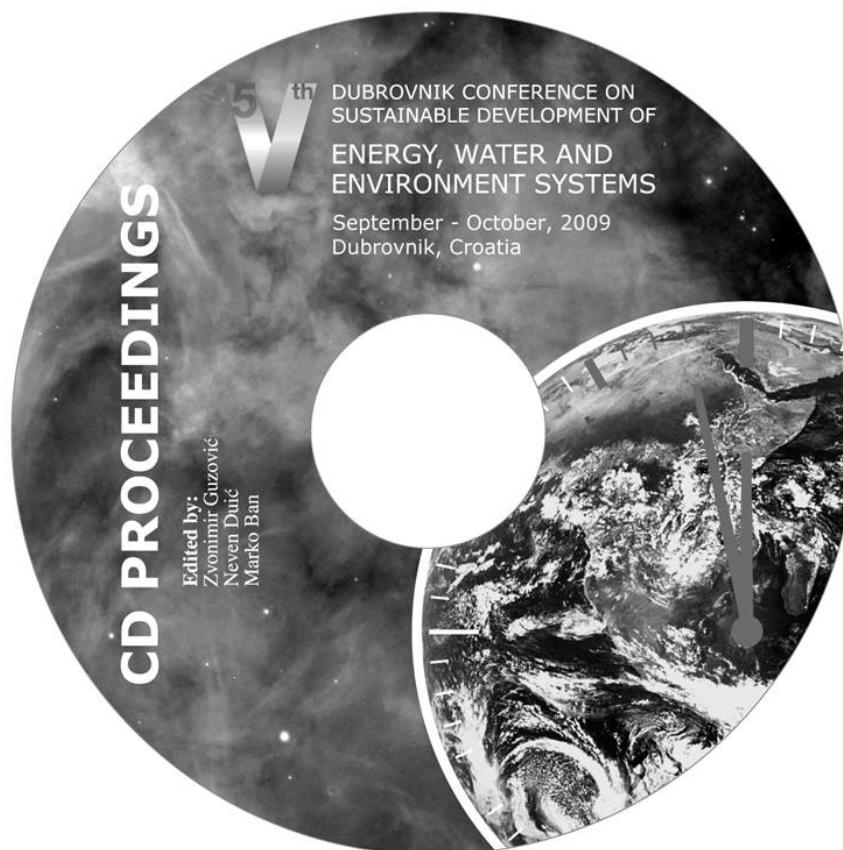
Electricity Transmission and Management ([Room C](#))

Sustainability in Buildings III ([Room F](#))

16:00 - 16:30 Coffee break ([HALL B](#))

16:30 - 18:00 Parallel sessions

18:00 - 19:00 Closing session ([Room A](#))



**To this Book of Abstract a CD Proceedings is enclosed,  
containing all the papers mentioned in full**

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## **BOOK OF ABSTRACTS**

## Invited Lectures

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SDEWES.2009.655

### **Sustainable Energy Development: The Present (2009) Situation and Possible Paths to The Future**

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#### **ABSTRACT**

Recent estimates and forecasts of the oil, gas, coal resources and their reserve/production ratio, nuclear and renewable energy potential, and energy uses are surveyed. A brief discussion of the status, sustainability (economic, environmental and social impact), and prospects of fossil, nuclear and renewable energy use, and of power generation (including hydrogen, fuel cells, micro power systems, and the futuristic concept of generating power in space for terrestrial use), is presented. Comments about energy use in general, with more detailed focus on insufficiently considered areas of transportation and buildings are brought up. Ways to resolve the problem of the availability, cost, and sustainability of energy resources alongside the rapidly rising demand are discussed. The author's view of the promising energy R&D areas, their potential, foreseen improvements and their time scale, and last year's trends in government funding are presented.

SDEWES.2009.609

## **How to Implement Renewable Energy Systems? Lessons Learned from The Danish Case**

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### **ABSTRACT**

With regard to the implementation of renewable energy systems, Denmark has become an interesting case. As many other western countries, Denmark was totally dependent on the import of oil at the time of the first oil crisis in 1973. Almost all transport and all residential heating were based on oil. And even 85 per cent of the Danish electricity supply was produced from oil. Altogether, prior to the oil crisis, more than 90 per cent of the primary energy supply was oil. Looking back more than 30 years later, Danish society has proven able to implement rather remarkable changes. First, half the oil consumption has been replaced by other fuels, i.e. coal, natural gas and, to some extent, renewable energy. Secondly, Denmark has managed to stabilise the primary energy supply at the same level as in 1972. This stabilisation is unique compared to other countries as it has been achieved simultaneously with a "normal western European" economic growth.

The primary means have been energy conservation and efficiency improvements in supply. Buildings have been insulated and CHP (Combined Heat and Power) production has been expanded. Thus, today, the primary energy supply for heating is reduced to two thirds of what was used prior to 1973, even though the heated space area has increased by more than 50 per cent in the same period. The renewable energy share of primary energy supply has increased from around zero in 1972 to 16 per cent in 2007 and wind power has become equal to a 20 per cent share of the electricity demand. Moreover, Denmark has started to produce oil and natural gas from the North Sea and is today more than self-supplied with energy. However, the Danish oil and gas resources are scarce and are likely to last for only a few decades. An interesting question is therefore, can Denmark convert to 100 per cent renewable energy within a matter of decades or will we have to return once again to former days of dependency on import of fossil fuels? Such question is indeed relevant not only to Denmark, but to Europe in general as well as the US, China and many other nations around the world.

The idea of the lecture is to unify and deduce the learning and results of a number of separate studies and thereby contribute to a coherent understanding of how society can implement Renewable Energy Systems. The presentation is based on 25 years of involvement in a number of important and representative political decision-making processes.

SDEWES.2009.638

## **Building a Low Carbon Society**

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### **ABSTRACT**

There is a wide consensus that we are approaching the sunset of the oil era in the first half of the 21<sup>st</sup> century. The price of oil on global markets continues to remain high and peak global oil is within sight in the coming decades. At the same time, the dramatic rise in carbon dioxide emissions from the burning of fossil fuels is raising the earth's temperature and threatening an unprecedented change in the chemistry of the planet, with ominous consequences for the future of human civilization and the ecosystems of the earth.

The triple threat of the global credit crisis, the global energy crisis, and the global climate change crisis are interwoven and feed off of each other. Addressing the triple threat to our way of life will require a new economic story that can remake civilization along sustainable lines. The European Union needs a powerful new economic narrative that will push the discussion and the agenda around climate change and peak oil from fear to hope and from economic constraints to economic possibilities. That narrative is just now emerging as industries across Europe begin to lay the groundwork for a Low Carbon Society.

As the European Union prepares for the 15<sup>th</sup> Climate Change Conference in Copenhagen, Denmark in 2009, it is critical that we reframe the discussion on climate change and energy security to the mission of making the transition to a Low Carbon Society. If we do not succeed in reorienting the climate change and energy agenda from burden sharing to commercial opportunities, it is likely that the Copenhagen Climate Conference will not achieve its full potential.

The key is to lay out a compelling 'social vision' to accompany the new economic vision. The Low Carbon Society provides the framework for the birth of a 'New Social Europe' in the first half of the 21<sup>st</sup> Century. Just as the distributed Information Technology and internet communication revolutions dramatically changed the social context, as well as the economic parameters of doing business, a distributed renewable energy revolution will have a similar impact on Europe and the world.

SDEWES.2009.682

## **Technologies and Policies for The Transition to a Sustainable Energy System in China**

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### **ABSTRACT**

China's rapid economic growth over the past few decades, and in particular over the past few years, has resulted in rapid expansion of its energy consumption. Coal currently accounts for approximately 70% of China's primary supply, and will continue to play a crucial role in powering China's economic development. The consumption of coal has been a major threat to China's environmental sustainability. The consumption of fossil fuels contributed to 87-89% of the total SO<sub>2</sub> emission in China during the 10<sup>th</sup> Five-Year-Plan (2000-2005), now makes China be largest CO<sub>2</sub> emitter in the world as well. At the same time, over 50% of China's oil consumption comes from the overseas market, causing a significant energy supply security concerns. China is facing an energy dilemma in the process of industrialization, urbanization, and motorization: Based on current scientific and technology knowledge, it is really hard for China to achieve cost-effective transformation to a sustainable energy system. This paper explores the current state of China's energy consumption, and options for the transition to a sustainable energy system. The paper begins with an overview of the energy supply in China including the current fuel mix, the structure of the industry, and projected investment and emissions trends. Section 2 examines, based on modeling analysis, the technological options that China would need to take for achieving transformation to a sustainable energy system, and Section 3 reviews the policy measures that have been implemented to promote the development and deployment of sustainable energy technologies since 2005. In the final section, further domestic and international cooperation initiatives that could shape the structure of China's future energy system are discussed.

## Special Session: On the Way to 100% Renewable Energy Systems

### SUMMARY

This session pose the question: How can we convert our energy supply to 100% Renewable Energy at a national scale? Around the world e.g. in US, in Europe and China, policies has been formulated with the objective of decreasing CO<sub>2</sub> emissions. And in many nations policies to raise the share of renewable energy are being initiated as part of the global response to climate change. In some countries NGOs, researcher and even governments have formulated the goal of converting the entire energy supply into being based 100% on Renewable Energy. This session temps to focus on the methodologies and practice in the implementation of such long-term goals. The session is open for presentation of studies of coherent 100% Renewable Energy Systems as well as recommendation of the first steps and studies of the role of single technologies. And the session welcome technical studies of system designs as well as social science studies of how to implement such technological systems.

Session organizer: **Prof. Henrik Lund**, Aalborg University, Aalborg, Denmark

*Henrik Lund is professor in Energy Planning at Aalborg University and Editor-in-Chief of Elsevier International journal Energy. He was head of department from 1996 to 2002 and holds a PhD in "implementation of sustainable energy systems" (1990). His area of expertise has for more than 20 years been energy system analysis, energy planning and energy economics. The International Energy Foundation (IEF) gave him a gold medal for "Best Research Paper Award" within the area "Energy Policies & Economics" in 1998. He has been involved in a number of research projects and committee works in Danish energy planning, and in the implementation of various local energy projects in Denmark as well as in many other countries. In 2005-2007 he headed an international research project ([www.project-desire.org](http://www.project-desire.org)) on the integration of wind and CHP and he is now the coordinator a research project on 100% Renewable Energy Systems involving most Danish universities ([www.CEESA.dk](http://www.CEESA.dk)). Moreover HL is the architect behind the energy system analysis model EnergyPLAN ([www.EnergyPLAN.eu](http://www.EnergyPLAN.eu)).*

SDEWES.2009.044

## **Ireland's Pathway Towards a 100% Renewable Energy System: the First Step**

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### **ABSTRACT**

Currently 92.6% of the energy used for electricity generation in Ireland is fossil-fuel based, and 59% of this energy is wasted due to transformation losses. Also, approximately 85% of the fuel consumed in Ireland is imported, which is an extremely volatile situation in the current economic climate. Considering these, and the fact that Ireland has an abundant renewable energy resource, as well as an obligation from the European Commission to supply 16% of the total energy requirement from renewable resources by 2020, it is essential that Ireland identifies the most effective transition from a fossil-fuel to a renewable energy system. Consequently, this study presents the first step towards identifying how this transition may be achieved. The energy-systems-analysis model, EnergyPLAN, was chosen for this investigation, as it accounts for all sectors that need to be considered for integrating large penetrations of renewable energy: the electricity, heat and transport sectors. Initially, a reference model of the existing Irish energy-system was constructed, and subsequently alternatives were compared to identify the most effective method of increasing renewable energy penetration. The results in this paper illustrate the first draft of a 100% renewable energy system for Ireland. However, these results have been completed based on numerous assumptions that will need to be investigated in future work, before a serious roadmap can be defined for Ireland's renewable energy transition.

SDEWES.2009.046

## **100% Renewable Energy Systems in Project Future Climate - the Case of Denmark**

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### **ABSTRACT**

Greenhouse gas mitigation strategies are generally considered costly with world leaders often engaging in debate concerning the costs of mitigation and the distribution of these costs between different countries. In this paper, the analyses and results of the design of a 100 per cent renewable energy system by the year 2050 are presented. Two short term transition target years in the process towards this goal are analysed for 2015 and 2030. The analyses reveal that implementing energy savings, renewable energy and more efficient conversion technologies can have positive socioeconomic effects, create employment and potentially lead to large earnings on exports. If externalities such as health effects etc. are included, even more benefits can be expected. 100 per cent renewable energy systems will be technically possible in the future, and may even be economically beneficial compared to the business-as-usual energy system. Hence the current debate between leaders should reflect a combination of these two main challenges.



SDEWES.2009.077

## **Prospects of Wind Power in a Sustainable Hungarian Energy System**

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### **ABSTRACT**

In this article we examined the possibilities that wind energy offers for Hungary, also we compared our current situation and possible ways of development to international trends. We studied how the wind turbines can promote our move to a 100% renewable energy system in Hungary? At the end of the last year the installed wind turbine capacity was 126.9 MW, these produced 110 GWh electricity. It was only 0.27% of the total production and therefore it is strange that the regulation system does not encourage the investments into this field.

As a matter of fact recent regulations have a rigorous restrictive role with a 330 MW capacity limit (until 2010) and with a financial penalty for those, who cannot comply with the reported power forecast.

The goal of this study is to quantify Hungary's different wind power potentials (technical, socio-economic, program) to reveal our real possibilities. We think that the special toolkit of geography can open new perspectives for the Hungarian regional development and energy planning. At the same time our examination covered the effects of the planning and regulating problems on Hungarian energy sector.

SDEWES.2009.078

## **Using Heat for Cooling in Biomass Based Energy Systems: Tapping the Potential Based on The Customers Needs and Contracting Model Implementation**

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### **ABSTRACT**

One aspect of biomass-based combined heat and power plants is to deal with the issue of the heat-demand during summer. Therefore the implementation of sorption-cooling has to be thought of. In order to connect combined heat and power plants with sorption-cooling the notion of the cooling potential (need for cooling) of a region is paramount to be able to evaluate the economic and technical implications of sorption cooling implementation. Two tools are introduced, which can be used by investors to make a quick first estimation of the cooling potential of a building and of a region. Based on the results of this estimation, further steps with regard to implementation can be taken by the investors. Concerning the cooling potential of a single building a standardized questionnaire is presented, which can be used for interviewing potential customers. In order to make an estimation of the cooling potential of a region benchmarks combined with statistic data are used. Regional benchmarks resulting from a delivery of the questionnaire can be directly fed into the tool presented in order to determine the potential of a region.

Usually the business field contracting (in the meaning of outsourcing financed by a third party) is used for the delivery of heat or measures of energy reduction. But contracting comprises also the delivery of cooling, which would be another possibility for combined heat and power plants to gain a higher efficiency during summer. In the second part of this paper existing contracting models are examined and discussed. The focus lies on the adaptation of contracting models concerning the special needs for the delivery of cooling. Specific criteria are elaborated, which can be used as a guideline by an investor, who wants to get started in the field of cooling contracting. The elected models are described meeting the specific requirements for cooling contracting, e.g. the calculation of investment needs and the knowledge of the technical equipment necessary for the adaptation of district heating for sorption cooling.

The project was funded by the FFG Österreichische Forschungsförderungsgesellschaft.

SDEWES.2009.079

## **Using Heat for Cooling in Biomass Based Energy Systems**

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### **ABSTRACT**

A big disadvantage of biomass-based combined heat and power plants is the missing heat demand during summer. This paper discusses a possible solution to that problem. Since the missing heat demand constitutes an economic drawback for biomass-fired power plants, the effects of upgrading three biomass-fired combined heat and power plants to combined heat-power-cooling-plants are being examined.

The main purpose of this paper is showing up the potential of increasing the efficiency of these energy systems based on renewables by providing the additional service of cooling in summer time. It is possible to increase heat demand in summer by applying thermal driven cooling - devices, the so-called sorption-chilling-devices. Depending on the boundary conditions such an upgrade can also improve the energetic and economic efficiency of the power plant.

A further advantage of an upgrade is that a given supplier is able to satisfy 100% of the energy-demand of its customer (power, heat & cooling), which leads in the majority of cases to decreasing costs.

Upgrading a biomass plant has to be considered carefully, therefore a further focal point is the availability of a tool that supports plant operators when making decisions. With that tool plant operators shall be able to estimate the technical feasibility of the planned upgrade. The aim of the research underlying this paper was the development of such a tool.

To create a tool like this several prior analyses had to be accomplished. This tool - briefly presented in this paper - is a technical guide, which shows the possible integration and implementation of the planned upgrade. Depending on the input-parameters a selection concerning the hydraulic integration of the thermal driven chilling-devices is made. Furthermore, the state of the art in biomass-fired combined heat and power plant technology and in thermal driven cooling-devices is shown.

The extended version of this tool allows the evaluation of the upgraded system and compares the planned upgrade scenario with the actual situation of the CHP. An economical, ecological and energy related evaluation of the actual situation and of the upgraded situation of the power plant is made on the basis of the input - data. Finally an integrated sensitivity analysis shows the impact of critical parameters on the profitability.

The project was funded by the FFG Österreichische Forschungsförderungsgesellschaft.

SDEWES.2009.159

## **Unearthing Waste`s Potential for 100% Renewable Energy Systems**

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### **ABSTRACT**

This paper focuses on the elaboration of the potential of the waste sector to contribute to the provision of 100% renewable energy systems. Waste is an abundant and locally available resource and in many cases it is (at least partially) of biogenic origin, therefore pursuing political goals in waste management by energetic utilization of waste contributes towards achieving political goals in the energy as well as climate policy, too.

However, it is shown based on the example of Austria that looking at energy systems on a national or international scale the waste sector is only able to contribute very little to the provision of the overall energy needed. It is different if one looks at specific energy systems in industrial sectors or on individual industrial sites. Here one must acknowledge that the energetic utilization of waste can have a high impact towards establishing renewable energy systems. Exemplarily this is shown by discussing the Austrian pulp & paper as well as the cement industry sector.

SDEWES.2009.255

## **Potential of Renewable Energy Systems in China**

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### **ABSTRACT**

This paper discusses the prospective of renewable energy in the process of sustainable development in China. Along with the high-speed economic development and increasing energy consumption, the Chinese Government faces a growing pressure to maintain the balance between energy supply and demand as well as reduce environmental pollution. To ensure energy security and mitigate climate changes the inappropriate energy consumption structure should be changed. As an alternative, a suitable infrastructure for the implementation of renewable energy may serve as a long-term sustainable possibility. Such sustainable energy strategy typical involves three technologies issue: energy conservation, efficiency improvement and renewable energy development. Denmark is an example of such strategy can be implemented and it shows the possibility of converting into a 100% renewable energy system. This paper analyses the current status and programming of renewable energy utilization in China and compares the potential of renewable energy sources and energy demand between China and Denmark. It proposes and discusses a forward-looking issue that is the perspective of a 100% renewable energy system in China. The conclusion is such development is not impossible in the future in terms of technology and domestic resources. Due to the uncertainty of estimation and exploitation level of renewable energy sources, energy conservation and efficiency improvement are essential for China to achieving the sustainable energy development.

SDEWES.2009.279

## **A Global Renewable Energy System**

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### **ABSTRACT**

In this paper we will test the ETSAP -TIAM global energy system model and try how far it can take us towards a global 100% renewable energy system with the existing model database. This will show where we meet limits in global resources and where we meet limits in the data collected to the model until now.

Results from the modelling are global gross energy consumption, emission of greenhouse gasses and thereby potential global increase in mean temperature. Furthermore, total system costs will be compared to a reference scenario.

The ETSAP-TIAM (TIMES Integrated Assessment Model) is a detailed, technology-rich global TIMES model. The structure and data came from the MARKAL-based SAGE model that was developed by the US Dept of Energy's Energy Information Administration ([www.eia.doe.gov](http://www.eia.doe.gov)). The results of ETSAP-TIAM studies have wide diffusion among the groups that assess climate mitigation policies through EMF and IPCC.

In TIAM the world is divided into 15 regions and the time horizon is 2100, which is needed for long-term climate mitigation policies. The main structure of the energy system is similar to the structure of many ETSAP-TIMES models, but with less emphasis on the technological details in the downstream sectors (transport, industry, residential, commercial and agriculture) and more focus on the energy resources in the Upstream sector, in which the global regions are divided into OPEC and non-OPEC countries.

In the analysis with TIAM we will focus on biomass, wind, photovoltaic and new hydro. This is all resources for which estimated potentials exists for all the regions. After utilising these resources the analysis will give a picture of the need for including other renewable energy sources and the need for more efficient energy use at the end-use level.

SDEWES.2009.324

## **The 100% Renewable Energy Town Frederikshavn**

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### **ABSTRACT**

The town of Frederikshavn in Denmark has undertaken the task of becoming a 100% renewable energy town. The town is well-provided with a number of options including off-shore wind power, waste incineration for heat and power production as well as low temperature geo-thermal energy usable for room heating.

In this article, a technical scenario is developed for the transition of Frederikshavn's energy supply from being predominantly fossil fuelled to being fuelled by locally available energy sources. The article focuses on all aspects of energy demand in the town of Frederikshavn i.e. electricity demand, heat demand, industrial demand as well as notably the energy demand for transportation.

The locally available energy resources are surveyed and through energy systems analyses, a system with the proper load following capabilities is developed with particular attention to the technologies with relocation possibilities needed for the integration of fluctuating energy sources.

SDEWES.2009.494

## **How to Achieve 100% RES Electricity Supply for Portugal?**

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### **ABSTRACT**

Portugal is country which energy system highly depends on oil and gas imports 85% in 2005 and 86% in 2006, which drives to share of RES in total primary energy consumption of 14% in 2006. Looking only the electricity production situation is little bit better. The share of RES in the gross electricity production varies between 20-30% and it is dependent on hydro power production in wet or dry years. This paper presents energy planning of Portugal's energy system and technical solutions for converting electricity production to 100% renewable on national scale. Planning has been based on hourly energy balance by use and adaptation of H<sub>2</sub>RES computer program. The H<sub>2</sub>RES model has ability to integrate different storages into energy system in order to increase the penetration of intermittent renewable energy sources or to achieve a 100% renewable island, region or country. Paper also represents stepping stone for studies which will give wider picture for matching renewable energy sources potential and electricity supply. The special attention has been given to intermittent sources like wind, solar and waves which should be coupled by appropriate energy storages filled by excess of produced electricity. Storage will also decrease requirements for installed power of generating units; it will help to avoid unnecessary rejection of renewable potential and will represent certain security of energy supply.



## Special Session: National Strategies for Sustainable Development

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### SUMMARY

In the European countries the National Strategies for Sustainable Development (NSSD) are at different stage of preparation and implementation, and each has a country-specific scope, content and strategic direction. The aim of this session is to get an overview of the state of preparation and implementation, discuss different approaches, learn from each other and possibly co-ordinate further work aiming at developing a common approach to NSSD preparation, implementation and organization.

*Session organizer: **Dr. Natasa Markovska**, Macedonian Academy of Sciences and Arts, Skopje, Macedonia*

*Natasa Markovska holds DSc degree from the Faculty of Electrical Engineering, Skopje, with thesis on solar energy technologies. At present she is an Associate Professor and a Senior Researcher at the Research Center for Energy, Informatics and Materials of the Macedonian Academy of Sciences and Arts (ICEIM-MANU). She is leading/participating in several research projects related to energy strategies, energy efficiency and renewable energy sources, as well as the environmental impacts of various energy technologies, including greenhouse gases emissions and climate change mitigation options. She is the Chair of the National Committee on Climate Change and National Focal Point of the Intergovernmental Panel on Climate Change. Prof. Markovska participated in the preparation of the Macedonian National Strategy for Sustainable Development, leading the working group on Energy.*

SDEWES.2009.397

## **The Czech Republic Strategy for Sustainable Development in The Process of Update**

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### **ABSTRACT**

The Czech Republic Strategy for Sustainable Development (CR SDS, NSDS) was adopted by the Czech Government Res. no. 1242 of December 8, 2004 as an overarching conceptual document reflecting the basic political and social consensus about the strategic goals and principles of the CR development in the future. The Strategy has six parts and covers all three dimensions of SD complemented by three other areas: research & development and education; European and international issues and good governance. The strategic goals (24) were further integrated into sectoral documents and policies. As a framework document, the Strategy doesn't contain any quantitative goals and shows the general way how to build SD concept in sectoral politics.

The NSDS provides a set of 87 indicators for assessing individual strategic goals. The progress reports on the NSDS of 2006, 2007 and 2009 are based on a set of 36 aggregated indicators covering the three pillars of SD and three additional areas listed above. The set of indicators is being developed and modified during the ongoing process of NSDS revision taking place between 2007-2009, with the stress for the national set of indicators to be more closely attached to international level and international comparison.

In December 2007, an interim document under the title 'Principles, Instruments and Proposals of Priorities for Completing the Update of the SDS of the Czech Republic (2007)' was submitted to the Government. A new date for completion of the Strategy revision has been set for November 30, 2009 (Govt. Res. No.1434 of 19 December, 2007). In the meantime, the NSDS of 2004 remains valid.

A Steering Committee (SC) of 11 personalities representing key players from ministries, academia and NGOs in the process of the document update was formed to discuss also a broader problems of strategic planning, coordination and methodological compatibility of the NSSD with other national strategies. In December 2008, the SC approved the proposed structure of the draft document (5 priority axes with 15 priorities). In January-February 2009, objectives were formulated so that the draft updated NSDS could enter public discussion (April - May 2009).

SDEWES.2009.402

## **Building Institutional Framework for Sustainable Development in Montenegro**

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### **ABSTRACT**

There are many proofs confirming the importance of sustainable development (SD) for Montenegro. First of all, considering the international aspect of SD, the current global economic crisis, and, particularly, having in mind the features of Montenegro, its geographical position and natural characteristics additionally emphasize that development on the principles of sustainability is the only way ahead for Montenegro. In 2002 Montenegro formed the first National Council for Sustainable Development (NCSD) in the Balkan region; in 2005 the Office for Sustainable Development (OSD) was established, and the Government adopted National Strategy for Sustainable Development (NSSD) in 2007.

With these developments, Montenegro created the most advanced institutional basis for sustainable development in the region. During the past two years, after carefully observing the functioning of the SD institutions in Montenegro, the OSD embarked upon the process of reform of the current national SD system. As a result, NCSD was fundamentally reformed, having its membership downsized and structure of representation transformed. The First Annual Report on the NSSD Implementation has been completed and the process of defining SD indicators commenced in cooperation with the UN Department for Economic and Social Affairs.

In this context, this paper proposes to critically examine the evolution of the set-up of the Montenegrin SD system, present the advantages and disadvantages of the government-anchored NCSD, and based on the lessons learnt present recommendations for policy makers for their endeavors in promoting SD in their own countries. The paper argues that only by effectively coordinating all sectors in the society and ensuring genuine participation of the outside-government stakeholders, the countries could ensure that SD principles are incorporated in the major national and local policies. The independence and pro-activeness in approach of SD institutions is essential in ensuring the supremacy of SD practices in decision-making.

Considering the similarities in the historic, economic and social development of the former socialist countries, the recommendations put forward by this paper and lessons learnt could be of particularly use for the countries of the Southeast and Central and Eastern Europe. The findings of this paper could also contribute to the wider professional and academic debate on proper way of setting the institutional system of SD.

SDEWES.2009.503

## **Sustainable Water Management in Republic of Macedonia**

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### **ABSTRACT**

The water as a resource in Macedonia is one of the most valuable national asset that should be protected and preserved with a view to gain future benefits and in order to provide condition for sustainable development of the country.

Water is a scarce and fragile resource that is unequally distributed in time and space, and climate change is expected to lead to more irregular and lower volumes of rainfall. The shortage of water, due to irregular rainfall and aridity, is a major constraint for agriculture, as irrigation is the largest consumer of water.

Additionally, the water scarcity is even more pronounced regarding the global water quality deterioration over the years. Lack of wastewater treatment facilities, remediation methods and adequate management have resulted in accelerated eutrophication processes and pollutant accumulation in almost all surface waters in the country. The groundwater sources are not under regular monitoring protocols, but are also inevitably under high pressure.

Nevertheless, the past decade is characterized with favorable changes for the Macedonian water management. In the field of infrastructure for the protection and rational use of water, the main issues in the country are related with the increase of the share of the population connected to water supply and sewerage networks and to urban waste water treatment plants.

This paper evaluates the existing water management in Macedonia to determine necessary measures to establish sustainable water management and will also review current major challenges to the evolution of the water supply and sewage systems. It also presents short term, intermediate and long term objectives, identifies issues related to the implementation of sustainable water management and presents measurable indicators for the monitoring of implementation process.

SDEWES.2009.506

## **Environmental Monitoring As a Basic Tool for Sustainable Development - Proposal for a Monitoring System in The Republic of Macedonia SD Strategy**

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### **ABSTRACT**

Beginning in the late 1980s, researchers within the Office of Research and Development at the Environmental Protection Agency conceptualized, designed and implemented an Environmental Monitoring and Assessment Program (EMAP). The EMAP was—and still is—designed to be a research-based (that is, having a focus on investigating in scientifically-defensible ways the bases and components of measuring and evaluating the condition of ecological resources) undertaking. As designed, its primary purpose has been to establish the scientific and technical capacity to support the generation of data and information of known statistical confidence to be used in the conduct of ecological resource status and trend assessments. An important aspect of the program is enabling the transfer of its theoretical, scientific and technical foundations to the monitoring sciences and technology communities domestically—and worldwide.

The bases and components researched by the program include:

- statistical (that is, probability-based) monitoring designs that can achieve scientifically defensible measures of changes in ecosystem condition; research on these designs has shown the workability of developing sampling strategies that can deliver data and other information along with understanding of the confidence that accompanies that data and information;
- development and validation of ecological indicators and indices that reliably describe the condition (referred to often as the 'health') of ecological systems (and their inherent processes);
- investigations into the scientific and methodological constraints to the comprehensive recognition and representation of spatial and temporal differences inherent in data and information collected within and across ecological systems; and
- studies of information management as a fundamental element in designing and conducting monitoring studies, and in analyzing, retaining and reporting the range of data and information associated with stated monitoring needs.

Having in mind the importance of the environment in Sustainable Development of the country, a new environmental monitoring system has been developed and accepted in the SD Strategy of Macedonia, based on EMAP principles and selected indicators. This paper presents the fundamental features, postulation and cross-cutting issues of the newly proposed monitoring system as a tool for the Sustainable Development of Macedonia.

SDEWES.2009.541

## **Policy Challenges to Build a Knowledge Society In Macedonia**

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### **ABSTRACT**

This paper addresses the main policy challenges towards building a knowledge society in Macedonia. Knowledge society encompasses variety of aspects determining the wealth generation and sustainable development, but it is primarily shaped by three core policy areas – education and training, research and development and industry. Those three policies were elaborated from the perspective of their current development in Macedonia, undertaken reforms, mutual coherence and crucial challenges with respect to the knowledge society. The paper analyses were largely based on the extensive theoretical and empirical research related to the subject. The need for developing better key policies and create a coherent policy framework encompassing all relevant policy aspects is stressed out as necessary to achieve progress towards knowledge society. In that respect, proactive policy approach is distinguished as vital to ensure an optimal balance between the knowledge and utilization of the available resources in a sustainable way.

SDEWES.2009.543

## **The "added" Values of The Macedonian Society from An Unexpected Direction**

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### **ABSTRACT**

The main objective of the paper is author's vision related with the possibilities of diversification of income in rural regions in the Republic of Macedonia.

The better level of organization and planning of the production in the Macedonian agriculture sector could bring better environment in overall regions where the diversification of the income in rural areas is possible. The higher security of the income could make the farmers more open and dedicated for other type of activities which are not exactly related "only" with prime-agriculture (to invest in some sort of finalization of prime-agricultural products from the farm, to combine the resources from the farm with SD resources in the municipality and in the region - renewable-energy production, to collect products from the forestry or to develop rural tourism on the farm).

Efficient institutional capacity will facilitate creation of SME's for off-farm activities for diversification of income in rural regions. Proper legislation for dual agro and of-farm business activities within the SME and Industry in the rural regions will contribute to the SD and rural development. High technology utilization within the off-farm business activities will contribute to the creation of efficient and environmental friendly SME sector in diversified rural areas. With a recycling of waste materials from the agricultural production, environmental friendly off-farm SME's in the rural areas can significantly contribute to the proper waste management, production of energy from RES and utilization of equipment and technologies/processes that will control the pollution of the environment.

The generated diversification of the income in the rural areas on the principles of SD will strongly push our economy, social and environmental quality of life for all citizens of the Republic of Macedonia. The "added values" of our society will come from an unexpected direction - from the rural development and improved quality of live in all parts of our country. The lower migration pressure on the overcrowded and stressful urban zones will create balance in all aspects of modern living. The better quality of life in the rural regions will bring better conditions for balanced sustainable development of our society and the country of Macedonia.



SDEWES.2009.544

## **Sustainable Energy Practices in The Rural Communities of The Republic of Macedonia**

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### **ABSTRACT**

The agriculture in Macedonia is using just 4% of the energy and the issue is raised about the possibilities to decrease the energy consumption and to diversify the energy sources. Macedonia is considered to be a country with a high potential to use sustainable energy practices and resources, particularly in the agricultural sector where biomass, biogas, solar energy, geothermal energy, wind energy and the hydrogen produced from the renewable energy resources are recognized as the most promising options. Therefore, our efforts should be focused on promotion and development of the sustainable practices for rural community in Macedonia, through in-depth analysis, comprehensive training and dissemination of the positive results.

The main goal of this paper is to present the plans and on-going activities related to the idea 'energy from - energy for agriculture'. Specifically, the project Agro-energy run by CeProSARD (The Center for Promotion of Sustainable Agriculture and Rural Development) will be elaborated as a practical step toward national sustainable development of the Republic of Macedonia.

SDEWES.2009.615

## **Sustainable Development Strategy of The Republic of Serbia**

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### **ABSTRACT**

The idea of National sustainable development strategies first evolved during the Rio Summit. National Strategies of Sustainable Development should be seen as a set of co-ordinated mechanisms and processes to help societies work towards sustainable development.

Republic of Serbia recently joined the family of NSDS countries. Government of Serbia adopted the National Sustainable Development Strategy in May 2008. The starting point in strategy development was to start from the existing adopted strategic documents and build upon them a concept of sustainable development which would bring together in a synergetic manner all three pillars - economic, social and environmental. The project was closely coordinated with the implementation process of the Poverty Reduction Strategy (PRS), and it was implemented in cooperation with the academic community and with the participation of country stakeholders in Serbia. It was build upon the work done for the PRS and initially focus on adding an environmental dimension that is expected to use inputs from the still ongoing work on the National Environmental Action Plan. The European Integration Strategy provided an input into the Sustainable Development Strategy for Serbia and aligned with the local sustainable development strategy prepared by the Standing Conference of Towns and Municipalities and a variety of existing sector strategies.

Moreover, Government of Serbia recently developed the Action plan for NSSD implementation. It is expected that in 2009 necessary institutional mechanisms for the implementation will be established (implementation teams within the ministries; establishment of the 'Friends of sustainable development' as business forum and 'Partners forum' as a link towards local communities, etc).

This paper aims to present the experience gained through the process of Serbian NSSD formulation and the main characteristic of final document and strategic formulation process. It will try to discuss the prospective of further implementation and barriers that should influence the process as well. At the end of the day, the destiny of NSDSs is similar like the destiny of all strategic plans: it can be implemented, or forgotten in the office of government officials. How it will be proceeding, depends of two influential facts: the political will and public awareness.

SDEWES.2009.623

## **Sustainable Development the Danish Way - Ensuring Sustainable Development Through Strategic Framework Planning and Vertical and Horizontal Integration**

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### **ABSTRACT**

Denmark was one of the first countries in the World to nationally recognise the increasing pollution problems and act decisively in the late 60ties and beginning of the 70ties. Denmark was one of the first countries to make a comprehensive national assessment of the state of the pollution and to establish the first Ministry of Environment (originally named Ministry for Abatement of Pollution) with a national Environmental Protection Agency. Integrated with this Denmark was also one of the first countries in the world to build up world class environmental research and development and teaching capacity at universities, research and development institutions and consulting engineering companies especially in relation to wastewater and solid waste management. In line with this Denmark has played an active role on all global conferences related to environmental protection and later sustainable development since the Stockholm Conference in 1972. The early start and the fact that environmental protection and later sustainable development has been on the political agenda and permeated the Danish society for over 30 years has created a special situation in relation to ensuring sustainable development. Most visible in the fact that Denmark only has a framework strategy for sustainable development and do not have a National Council for Sustainable Development. This paper will present and discuss the Danish way of ensuring sustainable development, assess the pros and cons, and identify and assess the special circumstances which has been the conceptual driver behind this approach. Finally lessons learned in relation to a more global context will be identified and assessed.

SDEWES.2009.677

## **National Strategy for Sustainable Development for Macedonia - Facing Implementation Start-up**

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### **ABSTRACT**

The National Strategy for Sustainable Development (NSSD) of the Republic of Macedonia is an important element among the priorities contained in the European Partnership and for the fulfillment of the commitment declared in the "Strategy of RM for Integration into the EU". The concept of sustainable development is one of the main goals of European integration and it is the core of the European model society. Therefore the NSSD for the Republic of Macedonia has an EU integration dimension.

The Government of the Republic of Macedonia has made a lot of preparations through development of the "Conceptual Approach towards Creation and Implementation of the National Strategy for Sustainable Development of RM" (2000), preparation of the "National Assessment Report for Sustainable Development" (2001-2002 for the participation at the World Summit on Sustainable Development in Johannesburg in 2002) and finally develop the 'Research Concept supportive to the creation and implementation of the National Strategy for Sustainable Development of the Republic of Macedonia', (2003), before started activities on preparation of NSSD in 2006.

The Strategy was completed in February 2009 and this implies that our country will soon face the challenges of implementing the strategy to create a new and better future balancing the use of our rich social, cultural and natural heritage.

This paper will present sustainability diagnosis for the RM with a focus to the vision, mission and objectives for economically, socially and environmentally balanced development. The NSSD focuses are on the time frame 2009-2030, projecting Sustainable Development Macedonia by 2030.

In the context of the paper an critically examine and evolution will be presented for the advantages and disadvantages of the country as Macedonia is with the lowest developed economy and economical growth in the Europe in relation to the own paths of SD development. There is no doubts that SD will be a process for Macedonia on a long run, but the success story will depend on the successful start up in particular to the institutional and organizational positioning of the implementation for the NSSD.

SDEWES.2009.689

## **Integrated Product Policy - Implementation Policy of Sustainable Consumption and Production**

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### **ABSTRACT**

Sustainable development is based on several principles, including achievement of sustainable forms of production and consumption. European Sustainable Development Strategy identifies them as one of the key challenges. One of the instruments to achieve sustainable patterns of production and consumption is through the implementation of the integrated product policy. The concept of integrated product policy is an approach which seeks to reduce the life cycle environmental impacts of products from the mining of raw materials to production, distribution, use, and waste management. The driving idea is that integration of environmental impacts at each stage of the life cycle of the product is essential and should be reflected in decisions of stakeholders.

IPP focuses on those decision points which strongly influence the life cycle environmental impacts of products and which offer potential for improvement, notably eco-design of products, informed consumer choice, the polluter pays principle in product prices. It also promotes instruments and tools which target the whole life cycle of products. The paper analyses an IPP tools in European Union and in Macedonian conditions also giving an recommendation for future steps needed in process of EU accession of the Republic of Macedonia.

## Special Session: Role and Responsibility of Local Authorities in Assuring Energy Supply and Energy Security for Industry and Population

### SUMMARY

The efforts that European Commission and governments of the members of EU are making in implementation of European energy policy in whole Europe mainly depends on how it will be understood, accepted and conducted by the local authorities. National legislation often expands responsibility from government to local community to consider how to provide energy to industry and population. Constant analysis and evaluation of examples of good practice is important, hence the pilot studies could be chosen as the guide for local authorities in Europe. These examples should be considered as a path to local communities for successful local and/or regional implementation of energy efficiency policy and secure energy supply to industry and the population for which they are responsible. Therefore, it is expected in this session that many of important segments such as: management, planning, supply, consumption, energy efficiency, environmental protection and application of new and renewable energy sources to be scientifically clarified in a way to create the most eligible conditions for the application of European energy policy at the local level. Regarding to this the main thematic areas will enclose:

- making local energy strategy (methodology and data base),
- distributive energy production and suitable technologies,
- use of local fuels (biomass, coal, waste) – case studies, best practice,
- regional use of local energy potentials,
- renewable energy sources,
- energy efficiency issues of municipal systems and industry, and environmental issues of regional and local communities.

*Session organizer: **Prof. Milun Babic**, Faculty of Mechanical Engineering Kragujevac, Kragujevac, Serbia*

*Milun Babic is corresponding member of Serbian Academy of Engineering Science. Since 1990 he is employed as a full professor at Faculty of Mechanical Engineering, University of Kragujevac, Serbia. During academic career he worked as a lecturer at several Universities and Faculties in the country and abroad. On the Faculty of Mechanical Engineering in Kragujevac, Belgrade, Nis, Pristina and at Faculty of Science in Bor he held undergraduate and postgraduate courses: "Energy and Environment", "Energy and Environmental Project Management", "Process Machinery and Plants", "Turbomachinery", "Hydraulic Power Transmissions", "Computer Application", "Special Pumps", "Fluid Mechanics and Fluid Transport", "Equipment in Hydraulic Facilities", etc. At Faculty of Mechanical Engineering in Kragujevac, besides teaching, he also performed duties of Vice Dean and Dean of the Faculty. He is now Chief of Department of Energy and Process Engineering and director of Regional Energy Efficiency Centre Kragujevac.*

*Milun Babic is also author/co-author of 265 science, research and scholar papers that are published in national and international scientific journals and conferences, 8 patents, 67 technical solutions-new industrial products and plants (which have patent character and now are integral part of national companies' production). He managed 87 science and R&D projects of regional, national and international importance. He published 8 monographies, 3 university textbooks and mentored 7 PhD theses, 11 master theses, 3 specialists and large number of graduate exams. He was the member of large number of comities for PhD and master thesis at Faculties of Mechanical Engineering in Kragujevac, Pristina, Nis, Belgrade and Novi Sad.*

*During his career Milun Babic also performed, beside others, several nationality important duties such as: Minister in Government of Republic of Serbia for Coordination of Industry Development, head of Republic Council for Energy Efficiency, member of Scientific Board for Energy Efficiency of Ministry of Science, coordinator and manager of Program of Development Strategy for Implementation of New and Renewable Energy Resources in Republic Serbia - Subprogram MoME for Development Serbian's RES's Strategy for the period 2006-2010., director of National Energy Efficiency Subprogram in Municipal Systems of Ministry of Science, local expert in international team for establishing of Energy Efficiency Agency of the Republic of Serbia and for preparing Energy Development Strategy of Republic of Serbia.*

SDEWES.2009.288

## **Energy Management Systems Applied to Bread Factory**

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### **ABSTRACT**

The Regional Euro Energy Efficiency Center Kragujevac (REECKG) is established in 2004 at the Faculty of Mechanical Engineering Kragujevac by assistance Serbian Energy Efficiency Agency (SEEA) and Norwegian Energy Efficiency Group. The basic tasks of Center are: creation of strategies, plans and studies of energetic development of local communities and companies, balancing of energy production and consumption, and establishing of energy efficiency of facilities and technical processes, financial energy engineering, energy and ecological monitoring and management, as well as transfer of knowledge and innovations to employees in these fields, substitution of conventional with renewable energy sources, creation of databases concerning energy resources in production and consumption of all energy types in the area where the Center is authorized.

Energy experts of Faculty of Mechanical Engineering together with energy team of the bread factory "Pobeda", Arandjelovac, conducted the energy audit during the winter/spring period of 2004. The team from the Faculty several times visited the company for assessment of plants, procedures and relevant documentation that describe the technology and energy system in order to propose energy saving measures. Internal expert team was formed and relevant employees were interviewed concerning the energy consumption. Beside, some measurements were made using portable measuring equipment owned by the faculty.

This paper summarizes the outcome of the performed energy auditing and proposes potential areas for energy savings. Generally, energy saving measures can vary between simple low-cost measures (basic operation precautions and good housekeeping) and capital investments. Interesting energy saving measures and projects that were determined during the energy audit were the subjects of feasibility studies in order to analyse each technical alternative or verify conclusions which have been reached.



SDEWES.2009.394

## **About Creation and Reached Goals of Development Policy in The Area of Energy Efficiency, Environmental Protection and Sustainable Development in The City of Kragujevac**

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### **ABSTRACT**

This paper presents a review of the methodology development and a part of the results achieved in the process of establishing an energy management system of the City of Kragujevac (Serbia) and its communal services. The paper is an overview of influential factors in the field of energy management, analyzes their impact on raising the energy efficiency of individual municipal services and the city of Kragujevac, as a whole. The research team of Department of Energy and Process Engineering at Faculty of Mechanical Engineering in Kragujevac operates for some time through Regional Euro Energy Efficiency Center (REEECKG). Department, according to its development strategy is dealing with issues of energy efficiency for years, and with establishment of REEECKG has become a part of the wider network of regional energy efficiency centers, which in many segments act as important factors in the creation and implementation of national energy strategy and policy and as a supporter of development in Kragujevac. Ministry of Energy and Mining (MoME) and Serbian Energy Efficiency Agency (SEEA) directly coordinate the work of REEECKG and other regional centers. The REEECKG gained experience through the implementation of R&D and commercial projects in the field of energy management, environmental protection and sustainable development. Because of this experience REEECKG was able to help the city administration to properly direct its energy and environmental development strategy and to create a benchmarking methodology for spreading best practice examples in the region. The paper also presents the most interesting scientific and research results achieved, in which participated RECEEKg, MoME and SEEA, and the experts from the government of the City of

Kragujevac and municipal companies that were the direct beneficiaries of realized results of scientific research in the following areas:

- development of energy management in municipalities and the establishment of energy planning at the local level;
- improvement of municipal services by applying energy efficiency measures in public enterprises (Energetika d.o.o. (district heating company), J.P. Čistoća (communal waste management), J.P. Vodovod i kanalizacija (water and waste water management));
- Promoting the idea and realized projects in the field of energy management, environmental protection and sustainable development at the Festival of energy efficiency (starting from this year, during whole April).

SDEWES.2009.600

## **The Role of Local Government in Local Sustainable Development Planning - Serbian Case Study**

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### **ABSTRACT**

Over the past decade or so, the concept of sustainable development has become a shibboleth, widely accepted as the way to live in harmony with the environment. Achieving the sustainability of national development requires a strategic long term approach that either integrates or encompasses different development processes in such a way that they can be as sophisticated as the development challenges are complex. In accordance with the conclusions of the Johannesburg Conference, local governments implementing the sustainable development are bound to enter a decade of accelerated action towards the creation of sustainable communities and protection of common world goods. Apparently with SD efforts on national levels, local governments also show significant achievements in SD planning.

The process of preparation and implementation of Local Agenda 21 may bring numerous benefits to a well-organized local government. The benefits include more efficient acceptance and management of change by local community, more efficient political development, enabling the local governments to recognize the needs of the community, higher cohesion of the community, stronger regional networking, reduction of costs, and healthier community.

This paper will discuss the case study of Serbia as an example how countries in transition should implement local policies of sustainable development and what obstacles such countries can face on the road toward the sustainability. Serbian towns and municipalities adopted Local Sustainable Development Strategy Paper (LSDS) in May 2005 as a strategic framework for local authorities to establish local SD processes. The Strategy was developed under the Program for Environmental Protection and Sustainable Development in Serbian Towns and Municipalities 2004 - 2006, administrated by Serbian Association of Towns and Municipalities (Standing Conference of Towns and Municipalities - SKGO) and supported by Norwegian Association of Local and Regional Authorities (KS). Up to now more than 30 (from 167) municipalities in Serbia adopted Local SD strategies and initiated the implementation of LA21. Simmilar programs have been established in countries in the region (Croatia, Romania, Bulgaria and others). The experience from Serbian two years pilot program on drafting local SD strategies in municipalities and obstacles observed during the process will be discussed.

SDEWES.2009.198

## **Towards Sustainable Energy Communities**

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### **ABSTRACT**

In the PRACTISE project, local communities of four countries of the enlarged Europe (Italy, France, Spain and Romania) are undertaking a number of actions for empowering local authorities in their energy management: assessment of the whole community energy consumption and renewables potential, diagnosis of public buildings consumption, questionnaires to the population (...), a comprehensive and consistent set of evaluation and awareness measures to settle a real energy citizenship. Having the politicians in is a key point and PRACTISE is based on Local Sustainable Energy Community Boards. At the project level, all benefit from working with communities from various contexts and size through technical exchanges and site visits; training the practitioners will be a key output of the project and it is very likely that concrete investments will be accelerated more than hoped at the end of it. PRACTISE is funded by the Energy Intelligent Europe Programme.

## Special Session: Integrating Waste and Renewable Energy to reduce the Carbon Footprint of Locally Integrated Energy Sectors

### SUMMARY

Energy use continues to rise and with it the emissions of CO<sub>2</sub>. Energy efficiency methods have been applied across sectors. Efficiency gains and energy use per manufactured unit have fallen, particularly in relation to the processing industry. Residential, work place, leisure, and service sectors still use large amounts of energy and produce large emissions of CO<sub>2</sub> despite efficiency gains. Successful strategies used in the processing industry for integrating energy systems such as Total Site targeting implementing advanced pinch methodology and heat integration, have been applied to locally integrated energy sectors. The recent results show that it can be successfully applied to integrate renewables into the energy source mix and consequently reduce the carbon footprint of these locally integrated energy sectors.

This session focuses on the schemes, research and tools for: (i) Maximum consumption of local energy sources, including the renewables and waste to energy; (ii) The development of solutions for regional energy supply chain taking into account the available energy resources, technical, economic, environmental and administrative constraints; (iii) Integrating waste and renewable energy to reduce the environmental impact of locally integrated energy sector; (iv) Application of multi-criteria decision making to sustainable energy planning.

Session organizers: **Prof. Jiri Klemes**, University of Pannonia, Veszprem, Hungary  
**Prof. Ferenc Friedler**, University of Pannonia, Veszprém, Hungary

*Jirí Klemeš - Pólya Professor and EC Marie Curie Chair Holder (EXC) at University of Pannonia, Veszprém, Hungary. Previously the Dpt of Process Integration and at UMIST and The University of Manchester, UK. Research in neural network applications at University of Edinburgh, Scotland. Comprehensive industrial experience, process integration, sustainable technologies and renewable energy. Successful applications. Managing 66 major European and UK Know-How projects and consulted on energy saving and pollution reduction. Editor-in-Chief of Chemical Engineering Transactions, Subject Editor of Journal of Cleaner Production, Dpt Regional Editor of Applied Thermal Engineering, Associate Editor for Heat Transfer Engineering and ENERGY; Cleaner*

*Technologies and Environmental Policies; Resources, Conservation and Recycling. In 1998 founded and is the President of International Conference Process Integration, Mathematical Modelling and Optimisation for Energy Saving and Pollution reduction – PRES*

*Ferenc Friedler is a leading research figure recognised throughout Europe and overseas. He is an invited presenter of plenary and key-note lectures of international conferences. He is a Professor of Computer Science, and in 2003 he has been elected a Dean of Faculty of Information Technology. He is the Chairman of the Informational Technology PhD program and the Vice-President of the Regional Centre of the Hungarian Academy of Sciences. He was given recently the Knight's Cross Order of Merit of the Republic of Hungary by the President of Hungary, 2003, Vaaler Awards for the industrial implementation of the research results, New York, U.S.A., 1997, László Kalmár Prize (John von Neumann Computer Science Society), 2003. He is author of over two-hundred papers, and co-founder of the P-graph and S-graph optimisation framework that has recently become part of Chemical Engineering curriculum. He is a member of International Scientific Committees of many conferences (VOCAL, PRES, ESCAPE, ICheaP)*

SDEWES.2009.706

## **Actions and Influence of The Multiple Decision Levels Over the Whole Energy Chain**

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### **ABSTRACT**

The beginning of the 21<sup>st</sup> century has been marked by the collective awareness of global warming and finite state of fossil resources. These pressing issues and especially climate change, led governments and local authorities to adopt ambitious energy-climate policies, aimed at decreasing greenhouse gas emissions and primary energy consumption.

Considering that about 70% of the world primary energy consumption arises from towns, more specifically from the transportation and buildings sectors, the latter will play a central role in reduction of primary energy consumption and in possible climate change mitigation actions. Technically, performances of urban energy system, are mainly influenced by demand-side dynamics (buildings characteristics, heating systems, electrical equipment, behaviour of final users, aso.), supply-side availability (waste energy resources, decentralized energy conversion systems, energy networks, aso.), as well as by the management of the whole system.

Simulation and optimization computing tools have been developed, notably at EPFL, and have allowed significant gains in understanding both demand - and supply side dynamics in urban areas. The project "Innovative tools for the planning and the management of energy systems in urban area", based on a strong partnership with four Swiss cities, aims at federating these existing models and methods, in order to develop and validate an integrated approach for the planning and management of energy systems in urban areas.

The first part of the project presented in this paper concentrates on determining how to implement the legal framework at different institutional levels in our integrated approach. There are five levels of decision able to influence the performances of urban zone in a Swiss city, namely the international, national, cantonal, municipal and individual levels.

The objective of this study is to develop an evaluation grid, which will be used to identify the influence of each decision level over the different energy chain levels (primary, intermediate, final, useful energy and energy services).

The results showed that beyond the constraints imposed by national and cantonal laws, ambitious energy-climate policies adopted by each level of governance certainly offer a lot of opportunities for the sustainable and energy-efficient development of urban areas. New regulations and associated instruments give to local decision-makers a set of arguments that can be used in a complementary way.



SDEWES.2009.565

## **Regional Renewable Energy and Resource Planning**

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### **ABSTRACT**

A novel approach to regional resource management has been developed tackling simultaneously important issues of biomass supply chain - transportation and land use. The biomass supply chain problem is complex due to the distributed nature of biomass resources and their low energy density requires large transportation capacity. The biomass growing requires considerable land areas often in competition with food production. The present approach is based on the Regional Energy Clustering (REC) algorithm (Lam et al., 2009). REC generates a biomass transfer network between the various zones in a given region. This is followed by grouping the zones into clusters using the combination of links and the overall energy imbalance as an objective function to be minimised. The information about the clusters is further analysed by Regional Energy Cascade. It estimates the energy target within regional supply chains and provides the result for energy flow evaluation in between the zones, the quantity of energy needs to be imported/exported and the locations of the demands. The cascade result is then further illustrated by using the Regional Resources Management Composite Curve (RRMCC). It graphically represents the relationship between the land use and the generation and consumption of energy. RRMCC is an energy planning and management tool that extends the evaluation of the trade-off between biomass generation and land use. The quantity of the energy and the area of land needed are shown on the x-axis and y-axis. The slope of RRMCC represents the land area (km<sup>2</sup>) required per unit energy (PJ/y). This relationship gives the option to the planner to assess the priorities: either to sell the surplus energy on the fuel market or use the land for other purposes such as food production. A case study demonstrates the application of the RRMCC to maximise release of the land and to maximise the biofuel production at the same time to secure the needed energy supply.

SDEWES.2009.613

## **Integrating Renewable Energy Sources into Extended Total Sites**

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### **ABSTRACT**

The paper demonstrates an extension of the Total Sites methodology covering the industrial, residential, service, business and agricultural customers taking into account the variability on both the supply and the demand sides. The renewable energy availability, the energy demands (heating, cooling and power) of the considered sites all vary significantly with time of the day, period of the year and location. Some of them are not predictable and changing in various time intervals. The challenge to increase the share of renewables in the energy mix could be met by integrating solar, wind, biomass, geothermal energy as well as some types of waste with the fossil fuels. Total Site CHP energy systems are optimised minimising heat waste and carbon footprint, and maximising economic viability.

The maximum availability of renewables is mostly limited. There are different heat sources and heat demands during specific time periods. A heat transfer strategy exploiting a short term heat storage could save energy when in one time period there is a surplus and in a later there is a deficit. This can be used to synchronise the heat sinks and sources over the site and the considered time horizon and if necessary a heat storage optimal design and capacity can be suggested. When they are available at right time and required capacity at feasible cost it could considerably increase the system efficiency. This methodology could contribute to the problem solution in terms of sizing and scheduling by providing targets to be achieved.

This approach has been demonstrated on an extended Total Site including two industrial plants, a residential area and an agriculture farm.

### **ACKNOWLEDGEMENT:**

The financial support from the EC MC Chair MEXC -CT-2006-042618 Integrated Waste to Energy Management to Prevent Global Warming - INEMAGLOW is gratefully acknowledged.

SDEWES.2009.620

## **The Changing Role of Afghanistan in Meeting China's Need for Primary Energy Resources**

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### **ABSTRACT**

Afghanistan has the role of a 'buffer state' again. It was originally established as a buffer state between the British and the Russian Empires. Its current role as a buffer state comes from the need to control China's access to the Iranian and Central Asian primary energy resources. As for executing this control, geographically Afghanistan is in a strategic position, due to which it has again become a buffer state between the USA and China, although it borders only China, and the common border is short.

Afghanistan's becoming a buffer state is a typical phenomenon of globalisation. The main point is that under the circumstances of globalisation there is no need for contact on land as defined by territorial borders.

The presentation will provide an evaluation of the importance, from the point of view of China, of the oil and gas pipelines already built as well as those under construction, with this evaluation itself being based on the results of comparing the capacities of oil and gas fields in Iran and Central Asia to China's energy needs as expected in the long run.

As a consequence, it can be declared that the buffer state status of Afghanistan is not likely to alter until 2020, and the changes that are capable of resulting in the cessation of this enforced role may occur between 2020 and 2050. One of the prerequisites of these changes is that there must occur a fundamental structural transformation in the energy demands of the Chinese national economy.

Involving extraterrestrial primary energy resources opens new dimensions of energy security; furthermore, it puts the problem of global security into new perspective as well. The degree of the complexity of the problems arising thereupon is so high that it cannot be calculated. This all raises the necessity of placing the problem solving capabilities of mankind on qualitatively novel grounds. The solution may lie in the development of a global network of problem solving in the sense that was foreshadowed by Leibniz long ago. The breakthrough will come in the field of energy security: within the confines of a concrete project, the development of the global network of energy security centres as virtual energy security centres has already started. Virtual knowledge centres of different types will also come into being, which in turn will lead to a fundamental rearrangement of societal relations in every country: the infinitely complex process of the evolution of a global information society will be revitalised.

SDEWES.2009.634

## **Energy Minimization in Distillation Schemes of Quaternary Separations**

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### **ABSTRACT**

The scope of this work is to investigate alternative distillation schemes for the separation of a four component mixture (quaternary mixture) into pure components by means of continuous distillation. Design and rigorous simulation of different distillation arrangements for the separation of quaternary mixture are studied for energy minimization and economic evaluations of the distillation schemes are also made.

The study is performed for the quaternary system of (Propane, i-Butane, n-Butane, i-Pentane) with high product purities of (95%, 90%, 90%, 95%) respectively, for the feed composition of (0.2753 , 0.2034 , 0.2146 , 0.3067 ). Eight distillation schemes are investigated: conventional direct distillation sequence without feed preheater, conventional direct distillation sequence with feed preheater, conventional direct distillation sequence with forward heat integration, conventional direct distillation sequence with backward heat integration, complex distillation sequence without feed preheater and using total condensers, complex distillation sequence with feed preheater and using total condensers, complex distillation sequence without feed preheater and using partial condensers, complex distillation sequence with feed preheater and using partial condensers. All of the above schemes are designed, simulated and economically evaluated based on the simple direct distillation sequence without feed preheater.

Simulation results indicate that the selection of proper integration method for each distillation scheme will reduce the energy consumption and TAC. For example, the application of forward heat integration to the base case is not efficient due to the wide gap in boiling points between the hot and cold streams. While in the backward heat-integration scheme, the boiling point gap was very small; the backward heat-integrated scheme is the winner scheme with energy saving of 22.06% and TAC saving of 14.14%. In our study the use of feed preheaters had saved 13.38% of energy and 12.36% of TAC in the complex schemes with total condensers. In case of partial condensers we have achieved 7.71% of energy and 6.11% of TAC savings in complex schemes.

SDEWES.2009.644

## **Adaptation to Climate Change Through Regional Stakeholders**

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### **ABSTRACT**

Also well advanced areas like the Metropolitan Regions of Central Europe will be affected by the climate change. Especially the densely populated and economically very active agglomerations have to face serious damages and large-scale economic losses in the case of extreme weather events. Consequently these regions have to improve their preparedness, they have to develop early warning systems and an effective emergency management and, finally, they have to reduce the damage potential by appropriate building precaution measures. In order to cope with the negative implications of the climate change as well as to make use of chances lying with these changes the probable impacts have to be assessed and strategies have to be developed for the individual sectors.

The research project to be presented 'Network for Climate Change Adaptation in the Region Starkenburg (South of Hesse, Germany) - KLARA-Net - is part of the funding priority of the German Federal Ministry for Education and Research (BMBF) 'Research for Climate Protection and Protection from Climate Impacts'.

In the first phase (2006-07) a regional network of stakeholders from the Region of Starkenburg was established which actively deals with the adaptation to climate change. The goal was to develop future-oriented and effective strategies for different stakeholders within the network, such as the building industry, agriculture and forestry, tourism and the health sector. The initiatives launched by the project not only illustrate measures to cope with and reduce climate-related damage, but also point out the potential for new products, public services, and business processes.

In the second phase (2008-2011), strategies are being mapped out to pass on the findings of the thematic groups on regional adaptation requirements to the regulatory and legislative level. In addition, the network is developing appropriate methods in order to accelerate the process of adaptation.

Phase II is implemented in close cooperation of the Technische Universität Darmstadt and INFRASTRUKTUR & UMWELT, Darmstadt (SME).

SDEWES.2009.666

## **Sustainability in The Food Sector: an Integrated Holistic Approach**

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### **ABSTRACT**

Sustainable development requires radical change of approach to processing in food industry where currently up to 60% of product is being wasted. Too often, effluents and by-products are being treated as waste and discharged in landfills. This creates unsustainable consequences to the environment. Along with huge losses of raw materials, the waste of water and energy are also very considerable.

There have been significant technological and methodological developments which enabled to considerably reduce losses of either energy, or water, or materials. Significant methodological development on pinch analysis for water and energy saving have been made and its successful industrial applications have been observed. Since the 90's the Process Integrated Environmental Protection (PIEP) has had much use in the chemical industries to minimize the continual creation of substances harmful to the environment. Technologies emerge that enable byproduct collection at the respective places where they come into the waste streams.

However if we want leap forward in sustainability of food processing industry, a holistic approach is required to identify most appropriate actions for improving system performance and efficiency, and to provide cost-effective upgrading strategies and practical engineering solutions. This holistic approach is a paradigm to systemize the energy and water process integration, chemical and byproduct pinch, total impact including the CO<sub>2</sub> profile and carbon trading considerations in the food and beverage sector. The holistic approach is implemented by examining integrated features with (i) Mathematical programming with application of optimization techniques, and (ii) Graphic-based process design methods, which is essential to ensure high sustainability and economics of the process, as well as to enhance current engineering, operation and design practices.

SDEWES.2009.014

## **Environmental Engineering Through Combined Emergy-water Pinch Analysis**

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### **ABSTRACT**

Emergy analysis and emergy synthesis are well-known methods but still trying to penetrate the environmental life-cycle analysis domain justifying their power in tackling complex relationships between natural resources, industrial activities, services and the economy. Created and predominantly used by environmentalists eMergy analysis makes courteous steps in the engineering circles. The Pinch analysis, established itself as a classical tool for analysis and management of resources through integration of processes towards better industrial efficiency. Both concepts are built on thermodynamic principles. Both are using attractive graphical representations plotting intensive over extensive parameters. The strength of Emergy analysis comes from the universality and comprehensiveness of considerations and from the life-cycle wide view on resources and services management with characteristic “memory” of effort invested into making that resources or services available for use. The strength and uniqueness of Pinch analysis is in the ability to set targets, assess the idealistic minimum resources required for a process prior to any design step. This means it gives in the hands of entrepreneurs a tool to judge the viability of production ideas and quick discrimination of options. Pinch analysis offers another unique feature and this is design or re-design guidelines. Here the environmental engineers have the chance to take the environmental analysis one step forward, not only using indices to compare options, but to be proactive and identify bottlenecks and follow the way to improve sustainability, decrease environmental impact without compromising the efficiency of industrial activities. This paper reports results of an ongoing project attempting to agglomerate eMergy analysis with Pinch analysis, focusing on the benefits from both concepts, but restricting the considerations to water management (fresh water minimization, water sources selection and wastewater treatment).

SDEWES.2009.440

## **Methodology for The Integration of Low Temperature District Network in Urban Area**

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### **ABSTRACT**

The energy services delivered to urban areas in Switzerland make up more than 45% of the national energy consumption. Thus, in the framework of the Tetraener European project<sup>1</sup>, a methodology has been developed to design low temperature thermal networks based on process integration techniques and GIS (geographical information system) database. Water is the renewable energy vector which brings the resource from a lake or river to the end-users. Connecting buildings to the network reduces the external energetic dependency of a given urban area as well as it contributes to reduce the CO<sub>2</sub> and other pollutant emissions in a densely populated place. Heat pumps located in the buildings ensure the heat transfer from the district network to the domestic loops. The grid use is versatile since it can either act as a heat source or sink depending on the need (heating/cooling). This work aims for an optimal integration of heating/cooling using pinch analysis for the design and/or retrofit of the network and building temperature control strategy.

The combined use of process integration techniques and GIS energy platform is illustrated with the GLN (Geneva Lake Nation) case study. This network located downtown Geneva uses water from the nearby Lake Geneva as an energy source for the surrounding buildings to take advantage of this local resource. Connected buildings to benefit from this sustainable system include those from international organizations. The latter clients have important needs especially in terms of cooling for their large-size conference rooms. The GLN network also acts as a source of non-drinkable water for fountains and irrigation purpose in the surrounding parks.



SDEWES.2009.631

## **Multi-criteria Decision Making Under Uncertainty: Energy Efficient and Low-carbon Wastewater Treatment**

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### **ABSTRACT**

Uncertainty appears across a wide range of fields from physics to statistics, economics, psychology, and engineering, among others. What concerns engineering, uncertainty maybe defined as 'the lack of certainty, a state of having limited knowledge about a system or process thereby unable to exactly define the future outcome as more than one outcome is possible'. Some possible outcomes of uncertainty may have undesired effects, e.g. significant loss or poor process performance due to suboptimal engineering decisions (oversized reactor design, inappropriate choice of controllers, etc).

Wastewater engineering is concerned with designing systems for removing pollutants from process or municipal wastewater thereby ensuring good effluent quality prior to discharge into receiving bodies (rivers, lakes, etc). Designing a wastewater treatment system is a multi-criteria decision problem as one needs to satisfy a number of criteria, namely environmental, economic, technical and legal criteria. Mathematical models are often used to quantify the multi criteria in question, e.g. energy demand, effluent quality, CO<sub>2</sub> production, operational cost index, etc. Next the design problem of wastewater treatment is further challenged by a number of uncertainties, which may be categorized as:

(a) External uncertainty: this has to do with uncertainty in quantity and composition (characteristics) of wastewater received by the system (it is imposed by the outside environment) and,

(b) Internal uncertainty: this has to do with uncertainty inherent to the system itself and its mathematical description. For example, the performance of biological reaction units in wastewater treatment systems is not fully known due to hard-to-predict underlying biological activity. Likewise, the mixing and hydrodynamics in the reaction units are not completely known. These uncertainties are typically reflected in the parameters and structure of the underlying mathematical description of the physical system.

Summarizing the problem of designing a wastewater treatment system has two dimensions: (i) complexity due to multi-criteria nature and (ii) uncertainty. The state-of-the-art (SOA) to dealing with this problem has been (and is currently) to use engineering standards (protocols based on previous industry experiences and knowledge) incorporating large safety factors. This approach usually ensures to satisfy legal and effluent quality requirements, however doesn't address the remaining criteria such as

economics (some safety factors result in over-dimensioning of reactor units) energy and CO<sub>2</sub> footprint.

To move beyond this SOA and thus enable making sound and optimal engineering decisions with respect to water and energy require a systematic framework for dealing with uncertainties. This contribution highlights the use of such a systematic framework in wastewater treatment design. In general, uncertainty analysis is concerned with propagation of the various sources of uncertainty to the model output. The uncertainty analysis leads to probability distributions of model outputs, which are then used to infer the mean, variance and quantiles of model predictions. The framework for uncertainty analysis relies on Monte-Carlo procedure as well as process models, which features the following steps: (1) identification of sources of uncertainty, (2) Monte Carlo simulations using process models and (3) quantification and interpretation of output uncertainty.

Aside to allowing engineers to systematically solve a multi-criteria decision problem under uncertainty, the framework help making engineering solutions that respects water quality but also generate energy efficient and low-CO<sub>2</sub> wastewater treatment systems. In this regards, the framework enables a new paradigm for design and operation of engineering systems.

SDEWES.2009.693

## **Capture of CO<sub>2</sub> from Flue Gas in Blue Algae Culture Broth. Mathematical Model for CO<sub>2</sub> Absorption**

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### **ABSTRACT**

Sequestration of CO<sub>2</sub> from industrial gases is an important and viable strategy for worldwide effort to reduce the human contribution to climate change. Stationary sources of CO<sub>2</sub> as power plants, oil refineries, gas processing plants, cement plants, iron and steel plants basically use fossil fuels as feedstock. The aim of this work was to propose and validate a mathematical model for the first step (absorption) of flue gas CO<sub>2</sub> sequestration with blue-green algae (species *Spirulina*) in fotobioreactors. A simple physical/mathematical model was considered for a double vessel bubbling reactor. Gas-liquid mass transfer with chemical reaction, specific to CO<sub>2</sub> – buffer solution Na<sub>2</sub>CO<sub>3</sub>/NaHCO<sub>3</sub> system was taken into account. Model parameters ( $k_L \cdot a_v, k_A, k_B$ ) were determined using least square fitting method from experimental data. Mathematical model predictions were compared with experimental results obtaining reasonable agreement into dimensionless coordinates. This model can be used for further process modelling in algae culture broth.

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SDEWES.2009.694

## **Vegetable Oil Characterisation for Biodiesel Synthesis**

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### **ABSTRACT**

Biodiesel is a renewable fuel derived from vegetable, animal or waste oils by the transesterification of contained triglycerides with light alcohols, such as methanol or ethanol. Existing biodiesel plant design and operation are based mainly on empiric approach. Thermodynamic and kinetic data acquisition (experimental vapour-liquid equilibrium, chemical reaction thermodynamic/kinetics, etc.), molecular modelling, computer aided molecular design - CAMD and computer aided process engineering CAPE) are necessary for innovative process development and existing process optimisation. In this respect it is important to improve analyse and characterisation methods for components and mixtures used in biodiesel synthesis. The scope of this research is to determine with new methods the composition and properties of vegetable oils that are usually involved in biodiesel synthesis. Then using chemometric methods correlation between those properties and biodiesel features can be deduced. In this work attempts are made to decide upon a number of analytical methods (chromatographic and spectral) that can be applied for the vegetable oils. Further it is interesting to correlate analyses results with important properties of biodiesel obtained from these oils.

The authors gratefully acknowledge the financial support provided by Romanian National Programme PNII grants no. 22138/PARTENERIATE and no. 1545/IDEI.

## Special Session: Biofuels Sustainability

### SUMMARY

Biofuels gain market as an energy source that can increase security of supply, significantly reduce greenhouse gas emissions as compared to fossil fuels and provide a new profits flow for farmers. However, many of the biofuels that are currently being supplied have been criticized for their unfavorable impacts on the environment, food security, and land use. Sustainability of a biofuel needs to be guaranteed in a transparent way; this includes aspects such as the social and economic development of local, rural communities, land use, agricultural practices, competition with food, air quality, water resources, agricultural practices, labor conditions, energy efficiency and GHG emissions, life cycle analysis (LCA), etc. The challenge is to support sustainable biofuel production, including the development of biorefineries, new second and third generation biofuels technologies as well as bio-hydrogen production systems in the most cost-effective way, with a commitment to improve production efficiency and social and environmental performance in all stages of the biofuel production system, together with responsible economic policies to secure that a biofuel commercialization is also sustainable. The session welcomes papers dedicated to different aspects of biofuels sustainability.

*Session organizer: Prof. Viatcheslav Kafarov, Industrial University of Santander, Santander, Colombia*

*Viatcheslav V. Kafarov is the Director of the Center for Sustainable Development in Industry and Energy, the Professor at the Faculty of Chemical Engineering and the Director of Post Graduate Programs of the Industrial University of Santander, Colombia. He obtained a PhD. in Chemical Engineering from Russian University of Chemical Technology - D.I. Mendeleev - Moscow, Russia in 1985, and Dr.-Ing. habil. in Technical Science at Martin Luther University Halle-Wittenberg, Germany in 1993. Since he entered at Industrial University of Santander in 1995 he develops research in the field of bio-diesel, bio-hydrogen, second and third generation biofuels production, sustainable development and Life Cycle Assessment for biofuels production, process integration and exergy analysis. He has been involved in a number of national and international research projects in biofuels and in sustainable development, most recently in international networks CYTED 306RTO279 - New technologies for biofuels production - and CYTED 307RT0324 - Hydrogen: Production and Purification; Storage and Transport -. He is author and co-author of more than 80 papers and 7 books.*

SDEWES.2009.392

## **Sustainable Ethanol Production from Lignocellulosic Biomass - Application of Exergy Analysis**

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### **ABSTRACT**

The rapid development of the world's bioethanol industry sparked a "food versus fuel" debate and further speculation about the industry's environmental impact. The processing of a renewable energy source usually involves the consumption of external energy and non-renewable resources; however, lignocellulosic biomass utilizes waste resources and, therefore, does not compete with food crops. To ensure the sustainability of the production of second generation biofuels, it is necessary to confirm that the energy content of biofuels produced from lignocellulosic biomass is significantly greater than the energy consumed in the process. Exergy analysis serves as a unified and effective tool to evaluate the global process efficiency. As bagasse does not jeopardize the food supply, this paper analyzes the integration of sugarcane bagasse as a raw material for second generation biofuels production. Exergy analysis evaluates the performance of sugarcane bagasse and its sustainability in the bioethanol production process. This case study implements a design and process integration to compare several biorefinery topologies using the typical daily amount of residual biomass produced by the sugar industry (1,200 tonnes). Based on the resulting bagasse chemical compositions (cellulose, hemicellulose and lignin), several process schemes were proposed to integrate the biomass into the biofuels production process. The exergy analysis concept puts forth the process scheme with the least environmental impact, or hence, the optimal process of second generation bioethanol fuel production from renewable resources. This study was executed by the use of the ASPEN-HYSYS® program and other software developed by the authors.

SDEWES.2009.473

## **Sustainable Biofuels Production in Brazil: New Generation Technologies for Bioethanol and Biodiesel**

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### **ABSTRACT**

The Brazilian Proalcool Program was responsible for substantial changes in the Brazilian society, contributing for its present position in terms of energy supply, with a great potential to increase. Due to its huge availability of energy resources, both from mineral and hydric resources, as well as various types of biomass, with technologies worldwide recognized, Brazil will probably be in a leadership position in the energetic market in the near future. Such impacts encompass clear categories: environmental, energetic, economic, social and technological. Due to the current use of by-products from the bioethanol production, mainly sugarcane bagasse, a potential for co-generation of renewable electric energy is being obtained. Nowadays, 93% of the bagasse is consumed as fuel for electromechanical and thermal energy, required for the processing of sugarcane. Concerning the social aspects, the sugarcane-alcohol industry is one of the largest industrial sectors, employing more than a million workers, half in the sugarcane industry and the remaining in the bioethanol sector. The sugarcane agroindustry was able to sustain a good part of this labour force in the rural area, highly contributing for a break in the rural migration, preventing the uncontrolled overpopulation in big cities.

In 2008, after two years of the implementation of the National Program for the use of Biofuels, Brazil already presents 55 new companies and approximately 65 companies involved in projects that include over 30 thousands of farms in the Program. Public offers, regulated by federal organizations, contribute for the coordination between farmers and consumers. The federal government, as well as the Petroleum, Natural Gas and Biofuels National Agency (ANP) are also responsible for a part of this production, in order to mix it with the diesel oil consumed in the country. Participating industries are constituted of authorized biodiesel producers with the stamp of a 'Social Fuel', certified by the Agroindustry Development Ministry. Today, the country includes 25 biodiesel producers authorized by ANP, with a total capacity to produce 600 million liters of biodiesel per year. This value is expected to reach 2.0 billion liters by the end of 2009 by 40 certified industries. The main consumers are Petrobras Brazilian Company and Refap Refinery, respectively in the proportion of 93% and 7%.

SDEWES.2009.497

## **Sustainable Production of Third Generation Biofuels - Case Study: Integrated Use of Microalgae Biomass for Bioethanol-biodiesel Production**

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### **ABSTRACT**

To achieve sustainable development within the biofuels industry, it is necessary to explore promising new alternatives. In this study, microalgae used in biofuels production, also called third generation biofuels, was analyzed because utilize less land and has a smaller environmental impact than do other crops. Process integration principles of mass and energy under uncertainty conditions were applied in order to enhance the economic competitiveness of the process. A design and process integration of bioethanol-biodiesel (200.000 l/day) production based on *Euglena gracilis* microalgae was executed. Several potential uses of whole microalgae in different biorefinery topologies were simulated using HYSYS-Aspen<sup>TM</sup> software under uncertain conditions developed by the authors. The microalgae obtained in raceway ponds are then used in the oil extraction stage to obtain oilgae. The residual biomass ('microalgae bagasse') was employed as a raw material for bioethanol production and then used, together with the oilgae, in the transesterification process to achieve third generation biodiesel production. The carbon dioxide produced during the fermentation stage was recycled to photobioreactors. Finally, the energy efficiency and the environmental impact of algae-derived biofuels were discussed.



SDEWES.2009.573

## **Assessing the Sustainability of Biofuels: a Logic-based Model**

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### **ABSTRACT**

During the last decade, the production and consumption of biofuels increased fast worldwide as a response to several challenges such as: reduction of greenhouse gas (GHG) emissions, diversification of transportation fuels, promotion of alternative fuels and employment creation or upholding, especially in rural and developing areas. While industrialized regions such as European Union are developing policy instruments in order to promote only sustainable biofuels, the issue of definition and assessment of sustainability remain at hot debate.

Many institutions and forums have worked on sustainability criteria setting and a consensus is being achieved on which key factors should be considered. The main concerns include the issues as follows: preservation of sensitive biodiversity areas which could be endangered by deforestation, low or no reduction of GHG, local environment impacts, misuse of water, risk of competition with food and other social imbalances, and finally economic inefficiencies.

Several countries have adopted obligatory targets or financial incentives and few states have developed sustainability certification schemes for those biofuels that will be accounted for within the policy framework. Deciding whether a given biofuel complies or not with the criteria of a certification scheme results from an assessment process. As number of the criteria is qualitative, subjective appreciations should be merged with quantitative evaluations.

In this paper, a logic based model is presented using a hierarchical structure between factors of various specificity levels and linking these factors step by step from the more specific variables to the most general one i.e. the sustainability. The proposed model is illustrated with the case of assessment of a given bioethanol in the framework of a labelling process.

Finally, the strengths and the limitations of the model are discussed as well as the envisaged improvements.

SDEWES.2009.575

## **R & D Public Policies for Ethanol Production in Brazil**

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### **ABSTRACT**

A great challenge is faced by the ethanol industry today: to improve overall productivity, decrease production costs and at the same time improve sustainability indicators. In this paper, different strategies conducted in Brazil are analyzed. The State of São Paulo Research Funding Agency-FAPESP has financed a research project to discuss issues related with sugarcane to ethanol in order to identify what needs to be done in this field. It is first recognized the biofuels costs and sustainability are very dependent on feedstock. In the case of sugarcane in Brazil 65-70% of overall ethanol costs are due to the cane itself. Also, most of the important parameters, like water use, fertilizer application, soil loss, are related to agriculture practices and influenced by established technology. Here, it is first discussed how agricultural and industrial productivities are evolving, which are future prospects, and second which are the most critical issues related to sustainability and how to overcome them. In this research project, 20 workshops were carried out in the last three years involving 10 research institutions in Brazil. Not only agricultural aspects were covered but also the so-called second generation technologies (hydrolysis, gasification, and pyrolysis mainly) and ethanol and its final use. More than 100 researchers were involved in these discussions. In this paper the results will be presented and transformed in public policies to provide subsidies to develop the future ethanol industry in Brazil.

SDEWES.2009.588

## **Issues to Consider, Existing Tools and Constraints in Biofuels Sustainability Assessments**

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### **ABSTRACT**

Last years the production of ethanol and biodiesel at a world level is increasing sharply. The depletion of oil reserves, high oils prices and the widespread confidence in biofuels carbon neutrality are the main causes of this phenomenon. Otherwise claims related to biofuel programs negative consequences are frequent, mainly related to the biofuels/food competition and also to sustainability issues.

In the paper are discussed which are the main issues to be considered during biofuels sustainability assessment and related indicators. A first approach must consider: the life cycle energy balance (output/input relation), the quantity of fossil energy substituted per hectare, sub-product energy allocation, life cycle carbon balance (including N<sub>2</sub>O emissions due to fertilizers application) and changes in soil utilization (former ecosystem).

On the other hand existing assessment tools, such as life cycle analysis and integral planetary assessments, are compared emphasizing on it advantages and disadvantages. Main constraint related to time and spatial frontiers of the studies and also the lack of reliable data about some issues and effects are discussed also. Discussions are carried out on the basis of real life cycle studies carried out by the author's for palm oil biodiesel. Finally suggestions and recommendations are done about how to improve existing methodologies and tools for biofuels sustainability evaluation, all this from a south perspective

SDEWES.2009.590

## **Production of Heavy Oil from Secondary Pulp/paper-mill Sludge by Direct Thermochemical Co-liquefaction with Waste Newspaper in Hot-compressed Water for Energy Recovery**

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### **ABSTRACT**

Secondary pulp/paper-mill sludge (SPP), the residue from pulp/paper industry wastewater treatment, is a waste biomass with a higher heating value (HHV) of 15.77 MJ per dry kg of TSS that can potentially be recovered through thermochemical processes. As with other types of biomass, SPP is a source of renewable energy contributing little to no net GHG emissions to the environment because of its carbon-neutral life cycle. Biomass feedstocks can be thermochemically converted into valuable organic liquid products at temperatures ranging between 150 and 420 C in the presence of hot-compressed or sub-/supercritical water, which is an effective and 'green' solvent for the direct liquefaction of biomass and, given the high water content of sludge, can act directly in a co-liquefaction process. Hence, the energy-and-capital-intensive pre-drying step, required in many conventional thermochemical treatment processes, can be eliminated. To improve the energy and capital efficiency of the process, it is preferable to liquefy feedstocks with relatively high solids contents (>10 wt%), which can be achieved by pre-mixing and co-liquefying SPP with other waste biomass feedstocks such as municipal solid waste (MSW). In this work, waste newspaper was used to represent typical MSW as it is readily available, homogeneous and consistent in composition, and has a high volatile, particularly lignin, content. The objective of this research was to investigate the effects of reaction temperature and the addition of selected catalysts (alkaline/acidic compounds, iron ore) on the product yields of sludge/newspaper mixtures in a batch direct co-liquefaction reactor process for heavy oil (HO) production. For comparison, dewatered sludge and newspaper/water mixture were also examined under similar experimental conditions to those of sludge/newspaper mixture.

SDEWES.2009.592

## **The Situation of Bioethanol and Biodiesel in Chile**

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### **ABSTRACT**

Chile is extremely dependent on foreign energy sources such as oil and natural gas, and there is a strong demand to reduce this dependence, a strategic threshold able to guarantee stability and the basis for economic development. However, Chile faces a difficult dilemma: the country does not have enough lands and soils available to be used for producing energy crops. Its installation should generate a competence for surface originally destined for food. Under this extremely difficult scenario, the country has proposed the establishment of a public policy that involves the diversification of the power matrix, based on the increasing participation of non conventional renewable energies. This last fact promotes the use of non traditional resources such as lignocellulosic materials. Energy supply derived from lignocelluloses transformation should be stimulated in the medium and long term. Actually, the funding of big projects of applied research that involve the participation of technological entities and companies has been initiated. These initiatives have included: a survey of agricultural and forest resources, the introduction of new species and energy crops, characterization and quantification of raw materials, studies focused on the transport, management and transformation of lignocelluloses for producing second generation biofuels such as bio-oil and bioethanol, based on the application of thermochemical and biochemical strategies. Also, human resources qualification has been considered as a fundamental step in order to attain these objectives.

The actual regulatory framework permits the substitution of 2 or 5% of the gasoline and diesel by ethanol and biodiesel respectively, but this change is very recent and not mandatory.

Private initiatives that consider the production of first generation liquid biofuels are waiting for the establishment of governmental policies, that include subsidies and management of invest in biofuels. It is expected that the use of mixed fuels start with imported products in a first stage. This situation could be maintained on time depending on costs of the imported biofuels and those involved on their local production. In 2015 it

is expected the beginning of local production of second generation biodiesel, derived from Fischer Tropsch processes based on the gasification of residues.

SDEWES.2009.595

## **Effects of Operating Conditions and Biomass Fuel Properties on Emission Performance and Combustion Efficiency of a Swirling Fluidized-bed Combustor**

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### **ABSTRACT**

This work reports an experimental study on firing 80 kg/h rice husk in a conical swirling fluidized-bed combustor using an annular air distributor as the swirl generator. Two NO<sub>x</sub> emission control techniques were investigated in this work: (1) air staging of the combustion process and (2) firing rice husk as a moisturized fuel. In the first test series for the air-staged combustion, CO, NO and C<sub>x</sub>H<sub>y</sub> emissions and combustion efficiency were determined for burning “as-received” rice husk at fixed excess air of 40%, while secondary-to-primary air ratio (SA/PA) was ranged from 0.26 to 0.75. The effects of SA/PA on CO and NO emissions from the combustor were found to be quite weak, whereas C<sub>x</sub>H<sub>y</sub> emissions exhibited an apparent influence of air staging. In the second test series, rice husks with the fuel-moisture content of 8.4 to 35% were fired at excess air of 20 to 80%, while the flow rate of secondary air was fixed. Radial and axial temperature and gas concentration (O<sub>2</sub>, CO, NO) profiles in the combustor, as well as CO and NO emissions, are discussed for selected operating conditions. The temperature and gas concentration profiles for variable fuel quality exhibited significant effects of both fuel-moisture and excess air. As revealed by the experimental results, NO emission from this conical swirling fluidized-bed combustor can be substantially reduced through moisturizing of rice husk, while CO is effectively controlled by injection of secondary air into the bed splash zone, resulting in the low CO emission and high (over 99%) combustion efficiency for wide ranges of fuel properties and operating conditions.

SDEWES.2009.596

## **Technico-economic Evaluation of Alternatives for Assimilation of Ethanol Production Technology from Sugar Cane Bagasse**

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### **ABSTRACT**

Considering the studies of technological monitoring to ethanol production from ligno-cellulose residues, a strategy of investigation for the elaboration of technological layouts considers using sugar cane bagasse. The pretreatment system used in two stages that combine diluted acid hydrolysis and Organosolv process with ethanol, allows the integral advantage of this remainder of the sugar industry. The investigation strategy included the Box - Wilson optimization method, analyzing alternative of pretreatment. Also, were obtained according to the used design of Plackett-Burmann, 8 alternatives of operation and they quantified its effect in the most important parameters of this process, such as glucose yield per grams of initial raw material and glucose concentration in enzymatic hydrolysis. It was realized a balance of mass and energy for the two better alternatives of the obtained results, and the intermediate currents were evaluated for different coproduct destinies. A scale-up study was realized for a plant that processes 21000 tons of bagasse to year and the evaluation of the requirements was considered production investors considering in the selection of the equipment and the sequence of the flow of the process the industrial experience of other industrial facilities that use the bagasse like raw material. One analyzes in addition environmental factors that influence in the process for the establishment of an adapted proposal of strategy of assimilation of the technology in conditions for diminishing the different remainders from the process. The evaluated alternative allows supplementing to sugars available of an alcohol distillery from cane molasses with bagasse sugars until lifting the capacity of production of the distillery in a 20%.



SDEWES.2009.568

**Joint Application of Process System  
Engineering, Life Cycle Assessment and  
Economic Evaluation for Sustainable Biodiesel  
Production from Palm and Castor Oil**

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**ABSTRACT**

Decision making about produce or not a certain type of fuel and how, is a problem either: scientific, technological, economic, financial and environmental. There have been developed several tools to take decisions based on each one of the approaches to the problem. Process System Engineering (PSE) methodology solves the scientific and technical problems, Economic Evaluation (EE) determine the economic and financial aspects, and finally to evaluate the environmental impact the Life Cycle Assessment methodology (LCA) is widely used.

In this work, an approach based on the joint application of Process System Engineering, Life Cycle Assessment (the methodology known as "from well to well") and Economic Evaluation for sustainable biodiesel production from palm and castor oil was applied. The environmental impacts generated in the biodiesel production are evaluated, taking into account that a percentage of the total residues is fixed by the nature due to the different biogeochemical cycles. Data and calculation procedures were collected in order to quantify the most important inputs and outputs of the systems in study at specific Colombian scenarios; also, the biogeochemical cycles were integrated along with the models pertaining to the different phases of the cultivation, the industrial transformation, the use as biofuel and the residual disposal. The categories of impact studied were: climate change (CCI), acidification (AI), eutrophication (EI), photochemical smog formation (POI), respiratory effects (REI) and non-renewable energy (NRE), so it was possible to obtain the environmental profile of the system studied.

SDEWES.2009.574

## **Improving Sustainability of Bioethanol Production: Efficient Ethanol-water Separation Processes**

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### **ABSTRACT**

Ethanol-water separation is a critical step in bioethanol production, representing a large fraction of the energy consumption of the whole production process. Bioethanol is produced from fermentation of sugars, which under current process conditions yield a wine containing from 7 to 12 wt% ethanol. In order to be used in a mixture with gasoline, anhydrous bioethanol (at least 99.3 wt% ethanol) must be produced; because of the azeotrope formation with water at 95.6 wt% ethanol at 1 atm, conventional distillation is used to produce hydrous bioethanol (93 wt% ethanol), but it can not achieve the separation required to produce anhydrous bioethanol.

Nowadays, conventional distillation columns are employed to concentrate wine and produce hydrous bioethanol, which is then fed to a dehydration system. A series of distillation and rectification columns operating under near-atmospheric pressures is employed. It is not unusual to find high energy consumption and ethanol losses in the industrial process, since the same process configuration has been employed for decades.

Brazil has been producing ethanol on a large scale basis for more than 30 years. The most usual process for ethanol dehydration employed in this period was azeotropic distillation with benzene, which has been replaced by cyclohexane for the past decade due to safety concerns. Up to this day, it remains the most common dehydration method, followed by extractive distillation with monoethyleneglycol (MEG) and adsorption onto molecular sieves, which have been used since the 2001 and 1999 harvest seasons, respectively.

In spite of being the most common dehydration process, azeotropic distillation with cyclohexane presents several disadvantages, such as high energy consumption on columns reboilers, use of a harmful and fossil separation agent and product contamination with solvent. Extractive distillation with MEG requires less energy, but it is also based on a fossil and harmful separating agent. Adsorption onto molecular sieves, on the other hand, is the most environmental friendly commercial process available: no toxic or fossil separating agent is used, final product is not contaminated and energy consumption is relatively small.

SDEWES.2009.576

## **A Review of Recent Development and Future Prospects of Dimethyl Ether (dme) and Adaptive Real-time Optimization Scheme**

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### **ABSTRACT**

Main topic of this paper is about reviewing for developing process optimization of novel energy systems including dimethyl ether (DME) and biomass processes. DME can be synthesized from natural gas, coal, biomass, and/or coal seam, and is a sulfur-free, near-zero aromatics synthetic fuel which is considered as an excellent substitute for conventional diesel and liquefied petroleum gas. Currently, various production technologies are developed and many commercial projects are actively being progressed. This paper presents recent development and future prospect of Dimethyl Ether (DME) as an alternative energy and simple review for biomass energy. One of major issue in containing abnormal or uncertain situations using dynamic optimization is to assure “robustness” against uncertainties in the model and external disturbances with quantifiable risk terms. This will be done by defining penalty value term for undesirable states identified by a scheme within an Approximate Dynamic Programming (ADP) formulation. When optimizing novel energy systems using modeling and simulation where convergence time is very long, the ADP frameworks would be very effective. The ADP-based method has been gaining more popularity in the fields of real-time optimization problems due to its promising features. In this paper, an emerging novel energy, DME, and ADP-based method are reviewed and we would like give on an idea on how to integrate ADP-based method into novel energy systems.

SDEWES.2009.591

## **Optimal Selection of Ann-based Soft-sensor Architectures for Continuous Flash Fermentation Using a Screening Method**

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### **ABSTRACT**

In the continuous flash fermentation, the performance of the whole process is significantly influenced by the relationships between process variables in the reaction and separation units. Thus, the availability of an accurate mathematical model is important to improve process performance and to define the most suitable operating conditions to achieve a particular objective. However, modeling of reaction-separation systems is extremely complicated. In the case of the flash fermentation the difficulty is the modeling of the vapor-liquid equilibrium for the fermented broth system, which is a complex multicomponent system with varying composition.

Another important application of an accurate mathematical model is the monitoring of the process states, which is an information source for the decision making in the production process. In general, monitoring of ethanol profiles in industrial plants is carried out as off-line analysis, often with a significant time delay between sampling and availability of the analysis results. An appropriate mathematical model can be used as a software sensor and allow real time monitoring of important variables.

The so-called software sensor is an algorithm where several measurements are processed together. The interaction of the signals from on-line instruments can be used for calculating or to estimate new quantities (e.g. state variables and model parameters) that cannot be measured in real-time. The major purpose of using software sensors in bioprocesses is to assess the quality of the final product and to validate on-line analyzers, providing redundant measurements. Artificial Neural Networks (ANN) has been dominant in literature in the field of software sensor design.

When ANNs are used to build inferential measurement systems, a study of their architecture is crucial in order to provide a reduction in the dimension of the input space, which can remarkably reduce the time needed for training. Another important issue is to identify among large numbers of possible input variables the ones that are significant for the desired response.

In this work, ANN-based software-sensors have been developed for the on-line estimation of ethanol concentrations in a continuous flash fermentation process at laboratory scale. Plackett-Burman design was used to evaluate the influence of various considered input variables in the concentrations of ethanol in the fermentor and of condensed ethanol from the flash vessel.

## Special Session: Interconnected Crises: Energy, Climate, Demography and Economy - New Approaches to Solutions

### SUMMARY

Every crisis presents both risks and opportunities. In this session we primarily aim to address the opportunities for a sustainable solution to crises in energy, climate, demography and economy, which would assure economic development, social cohesion and environmental sustainability in the emerging global sustainable knowledge society. This session organised in cooperation with The Club of Rome - European Support Centre and National Associations will study the long-term aspects of some opportunities for sustainable solutions of the current crises. It will discuss the concept of competition in promoting innovation for sustainable development and how to convert the vision of sustainable knowledge society into practical solutions.

Session organizers: **Prof. Aleksander Zidanšek**, Institute Jozef Stefan, Ljubljana, Slovenia

**Prof. Ivo Šlaus**, Croatian Academy of Sciences and Arts, Zagreb, Croatia

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*Ivo Šlaus is Emeritus Professor of Physics, member of the Club of Rome, fellow of the World Academy of Art and Science, member of the Croatian Academy of Sciences and Arts and founding member of Academia Europea, President of the International Network of Centers for Sustainable Development in South East Europe.*

SDEWES.2009.581

## **From Crisis to Economic Development and Social Cohesion**

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### **ABSTRACT**

The economic crisis which today shakes the whole world is the greatest challenge facing the globe and each individual state. In mid-October 2007, Rodrigo Rato said that the financial crisis is the biggest problem, more important than terrorism, the danger of weapons of mass destruction and the war in the Middle East. The current financial stress affects almost all countries. The world is in a global economic and moral crisis compounded by the destruction of our environment, by scarcity and unreliability of energy supplies, by declining social capital - lack of trust among people, of self-confidence and of leadership. All these crises are interconnected and interdependent, and we studied them using self organised modelling approach. This analysis of the current situation and suggestions for possible approaches and solutions are based on the use of several socio-economic indicators.

SDEWES.2009.254

## **A Social Pillar for Sustainable Development: the Demographic Revolution**

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### **ABSTRACT**

A recent study of the United Nations indicates that in the year 2050, the world population will include almost two billions people over 60 years of age, corresponding to about 22% of the total. The majority will live in those countries we define today as developing.

Keeping this figure in mind, we propose to consider and discuss, among others, that:

- The lengthening of the life cycle is a unique revolutionary phenomenon, having a profound impact on contemporary and future societies. It concerns the social, political and economic institutions in a far deeper sense that it is still commonly perceived.

- People in older age, over 60, 70 and 80 have always existed. But they were special cases representing a minute minority. Now the lengthening of the life cycle concerns and extends to the majority of the population. It is a mass phenomenon.

- The lengthening of the life cycle is a world wide phenomenon. From the "older" industrialized countries it is extending to the large majority of communities, almost everywhere.

- The lengthening of the life cycle is often presented as the problem of "ageing of population". What is really ageing is the notion of older age itself. Taking into consideration the ability of each individual to be autonomous ( in physical and/or mental terms ) , many studies and surveys indicate that in the average a 60 or even a 80 years old person of today, correspond to a person about 15/20 years younger living one century and more ago. Statistics based not on age but on capacity to perform, indicate in fact that in many countries, the population is not "ageing" but "rejuvenating" . In fact we live in a "Counter-ageing Society" (see: [www.newelfare.org](http://www.newelfare.org)).

- The lengthening of the life cycle, in all its aspects, is then clearly the fundamental issue to keep in mind discussing social policies.

- At the basis of this: enhance the HUMAN CAPITAL at all ages.

- Another very important issue on which to invest research capabilities in the one or two next decades, is the reconsideration of the measurements which refer to the "Wealth of Nations" and from which to derive the most appropriate references for better welfare policies. In the Service economy, not all the "value added" measures indicate an increase in the level of wealth (for instance the costs to cope with pollution), whereas many developments in service functions and performances ( for instance in the case of many communication systems ) add to real wealth much more than usual value added references

indicate. In particular the notion of productivity, in a Service economy, is much more relevant with reference to performance in time (hence in a probabilistic system) than to the production factors costs ( in an equilibrium based system). But all this is linked to progress in economics as a discipline, and to its integration with environmental issues (which also pretend to solve the problems of the "Wealth of Nations", on the base of their "sustainability").



SDEWES.2009.680

## **Climate Change and Global Green System of Innovation**

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### **ABSTRACT**

Sustainable development has been described as the integration of economic, environmental and social priorities in decisions about the use of resources, including natural, human and financial, implying long-term continuity and ability to carry on with these activities indefinitely. The significance of the concept is strongly reinforced by the imperatives of anthropogenically generated climate change which seriously question the ability to continue with the current ways of development. They not only point the finger at humankind as the main culprit but also position humanity as being able to do something to redress the current negative forecasts. The main impact people have on the planet's natural environment is through the use of technology. Any technological choices made affect this capability to sustain life on Earth for the human and more-than human world.

The history of technology shows that throughout the years we have been locked into the use of particular technological solutions defined as technological trajectories triggered by waves of innovation. As a result we have been witnessing a co-evolution of the three sustainability aspects, economic, environmental and social underpinned by evolutionary changes within technology. What this paper analyses are some current trends in the evolution of technologies related to climate change as represented by patent data. It argues that we are yet to witness the intensity of activities associated with a new innovation wave of sustainable technologies. On the other hand the time horizon available to humankind to avoid irreversible changes in the planet's atmosphere is estimated only at around a decade. What individual countries, such as US and Australia, or the European Union are aiming to achieve will not be enough to deal with the scale of the problems. Targeted global efforts are hence required to allow for the new innovation wave to pick up and a global green system of innovation will be in a position to speed up this process. Based on a global sustainability value system, it will combine the power of science, research and development with financial institutions and attitudes towards risk generating the skills and labour force that can implement this new vision across all sectors of society in individual countries.

SDEWES.2009.214

## **Climate Change, Kosovo Energy Scenarios and Sustainable Development**

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### **ABSTRACT**

Climate change will be the first truly global challenge for sustainability. Energy production and consumption from fossil fuels has central role to climate change, but also to sustainability in general. Because climate change is regionally driven with global consequences and is a result of economic imperatives and social values, it requires a redefinition as to the balance of these outcomes globally and regionally in Kosovo. Kosovo as one of the richest countries with lignite in Europe with 95% of the electric power production form lignite and with 90% of transportation vehicles which are over 10 years old, represents one of the regions with the greatest CO<sub>2</sub> output per GDP, as well as one of the countries with the most polluted atmosphere in Europe. Various energy scenarios of the future are shown. We demonstrate that a transition to environmentally compatible sustainable energy use in Kosovo is possible. The main aim of this paper is to specify and analyze a set of possible circumstances that is consistent with a sustainable path of future development of Kosovo.

SDEWES.2009.256

## **Greenhouse Gas and Air Pollution Emissions and Options for Reducing from The Kosovo Transportation Sector-dynamic Modelling**

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### **ABSTRACT**

One of the primary sources of CO<sub>2</sub> and Air pollution in Kosovo (except Thermo Power Plant) are light-and heavy-duty vehicles (i.e., mobile sources as: cars, buses, tractors, vans, trailers, etc.). We develop a model in which we identify technology and policy options for reducing mobile source GHG and air pollution, and explain how these options might affect the different variables of a mobile source emission model. In Modelling the Dynamic Mobile Source Emission Systems in Kosovo, at first emissions of greenhouse gases and air pollution from two types of vehicles: light and heavy vehicles (cars, buses, tractors, vans, trailers, etc.), is calculated. The initial data values are taken from ESTAP (Energy Sector Technical Assistance Project) Kosovo and by the Motor Vehicle Registration Authority of Kosovo. For initial time we have taken the year 2000, and for age of vehicles we suppose that 90% of them are of the age >10 years. We have divided the vehicles in five groups according to the age: 0-2 years, 3-5 years, 6-8 years, 9-11 years and >11 years. For each cohort of vehicles we have input scrap page rate  $r_k$  factor (fraction of vehicles scraped while in the cohort) and increase rate factor while in cohort  $1+p_j(t)$  (imported vehicles per year for each cohort). The time dependence change for average kilometres travelled, emission factor for each GHG, total number of vehicles and increasing rate factor while in cohort are the nonlinear functions and this nonlinearity depends on many factors (renewable energy potential, road structure, new technology and environmental policies in Kosovo), whereas the scrap factor does not depend on time. The initial value data for average kilometres travelled, emission factor for each of GHG and total number of vehicles are taken from sources: MEM (Ministry of Energy and Mining). The IPPC Directive, The European Commission, 1996.

<http://www.ec.europa.eu/environment/ipcc/index.htm>, <https://www.ksgov.net/mem>, <http://enrin.grida.no/htmls/kosovo/SoE/energy.htm>.

Implementing the emission reduction policies and introducing new technologies in transportation, after the year 2015, a continual reduction in air pollution will take place, whereas the CO<sub>2</sub> output to the year 2025 will be reduced by 25% in comparison with the emission values of the year 2007. Total emission of GHG is calculated for the year interval  $t=2000-2025$

SDEWES.2009.346

## **Geopolitics of Energy and Climate Change in South East Europe**

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### **ABSTRACT**

Located between the regions rich in fossil fuels (Russia, Caspian states and the Middle East) and main Central and West European markets, South-East European (SEE) countries might become increasingly important as an alternative transit route for energy supplies.

Transit is a key factor in project planning and investment decisions. In addition to the geographical position, transit countries and regions have to be politically stable with supportive investment climate, including legally ensured rights of way in order to be attractive for investors. On the other hand, the investments have to be environmentally sustainable and economically viable to be attractive for transit countries. As following the construction phase the roles and negotiating powers change, legally binding and enforceable rules have significant impact on investment decisions.

The South East Europe is in this respect an interesting case. By adhering to Energy Community, all the countries of the region have signed to the EU competition, environment and transit rules.

The aim of the paper is to outline a complex relationship between energy and climate change considerations in decision making relevant for SEE. Relevant decision making is analyzed from perspective of domestic decision-making; project decision making at international level (e.g. investment decisions) and on the level of international legal instruments that can have significant impact on energy security and environmental sustainability in SEE.

The paper starts with brief overview of major planned infrastructure projects. Based on formal support for selected projects it is examined how interests of energy security and environmental sustainability are balanced in decision-making process in South East Europe. Second, the role of international instruments (primarily Kyoto and post-Kyoto regime, Aarhus convention, the Energy Community and the Energy Charter Treaty) for decision -making at national and project level is examined. Next, the importance of commercial, political and environmental considerations for decision making is outlined.

As a result, geopolitics of energy and climate change of SEE is outlined.

SDEWES.2009.639

## **A Crisis "of Democracy" or a Crisis "Within Democracy"**

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### **ABSTRACT**

The present global financial crisis produced an economic, moral, ideological and social crisis which has shaken the foundations of the »western« style of life. People lost their savings as the values of the shares declined drastically, their homes as the banks closed and stopped approving credits, and – most important of all – their jobs as there are no buyers for the products of the companies they worked for. Ecology seems to be forgotten.

There are many voices saying that the crisis shows how wrong free market economy is. This is driven by the desire of the individual to do well and become wealthy. The accompanying social and political systems are democracy and capitalism. Similarly there are voices claiming that the idea of democracy itself failed together with capitalism and that the world is ready for a new economic and social order. People do not specify what this new order should be like.

One seems to forget that Mussolini, Hitler and Stalin all came to power after the crisis between the I. and the II. world war with promises to create a new and more just social order. A common feature of all the systems was dictatorship and the absence of democracy.

In the following we will try to show that the present crisis is not a crisis »of democracy« but rather a crisis »within democracy«. The origin of the crisis is according to our opinion »structural« and »technological« though other reasons – ideological, moral, ecological – are playing a role too. The specific features of this crisis are its global nature and the shift of the center of gravity of economic activity to Asia, i.e., China and India. These features will remain together with democracy and free market economy long after the situation has stabilized, the present crisis vanished and the attention focused on the ecological problems of survival of the planet as a whole. Marxist like solutions or dictatorships are neither necessary nor productive in solving the problems of the present global crisis.

SDEWES.2009.654

## **The Sustainable Development in Greece and The Financial Crisis**

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### **ABSTRACT**

In this short talk some details and information about Greece will be given. Especially for the sustainable development, the factors, the indicators and connected systems that may influence Greece and SE Europe in general:

#### Climate and Air:

- Emission of Carbon Dioxide CO<sub>2</sub> and Sulphur Oxide SO<sub>2</sub>
- Emission of Nitrogen Oxides NO<sub>2</sub>
- Concentration of pollution in big cities and pollution control and Environmental protection as a % of GDP
- Ambient concentration of pollutants in Urban Areas

#### Energy:

- Energy consumption per capita
- Materials consumption per capita
- Infrastructure in non pollutant energy (water, wind, sea)

#### Demography:

- Population Growth Rate
- Mortality Rate (infant etc)
- Life expectance at birth

#### Economy:

- GDP before and after the crisis
- Inflation for the last 5 years
- External debt / GDP according to official information
- Actual crisis and measures to restrain the unemployment.

#### Waste Management:

- Percent of population served by a Waste collection system
- Generation of Municipal solid wastes per capita
- Generation of solid waste per capita
- Clean combustion in Greece and pollution control.

#### Water:

- Water exploitation index i.e. Annual withdrawals of ground and surface water /exploitable water resources
- Surface water quality
- Ratio of renewable water supplies to withdrawals.
- Water quality indicator
- Water consumption per capita per year

The question is how to solve this crisis and to prevent a future crisis. Stricter financial and banking regulations are necessary, but other things are necessary too.

SDEWES.2009.509

## **The Concept of Sustainability in The Social Sciences**

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### **ABSTRACT**

Since 'Our common future' (1987) the term sustainable development became widely used concept in social sciences especially in social ecology and urban sociology. Why should social scientists deal with environment? The impact of society on the environment is the result of the development of modern technology which is in a great deal built in special institutional set up and it is socially constructed (Pinch, Bijker, Law 1989). The origin of our impact on the environment is socially marked and so are many consequences. In the paper are discussed different concepts of sustainability and their use in social sciences in the attempt to explain the main social processes of contemporary society. Concept of sustainable development of society and its social acceptance depends on trust, cooperation and values, basic elements of social capital. Another concept related to sustainability is risk defined in the theory of risk society by Ulrich Beck. How to implement principles of sustainable development in the network, risk and consumer society in crisis? The answers are stating point in various policy recommendations.



SDEWES.2009.606

## **Self-organised Modelling of The Civilization Growth**

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### **ABSTRACT**

We simulate the complex system of the socio-economic indicators in order to satisfy catastrophic condition in topological dynamics of attractor space. Based on results of the analysis of critical transition of the observed socio-economic indicators we analyse the conditions for this transition in attractor space. Our aim is to illustrate the influence of the financial centres on civilization growth through indicators such as interest rate shocks and commodity price collapses, and influence of the domestic debt in transformation of the country from emerging markets to advanced economies.

Results of this simulation have been verified with historical financial crisis data.

SDEWES.2009.690

## **Management of Human Resources in Crisis**

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### **ABSTRACT**

When explaining the English term 'Human resource management' different explanations are available. Authors describe it in many different ways; the most common description is given as 'Management of human resources'. Our opinion is that especially in recession and crisis this is not really appropriate. In a crisis situation, it is better to use a term 'Management of staff', because it is crucial to understand concepts like resources, human resource department, recruitment process, etc.

Volatile market affected by crisis in economy and also finances forces organizations to deal with several changes. Organizations which think that on market they are facing a stable situation are more or less inefficient. Furthermore resources have their own capabilities (knowledge, capabilities, motivation, ...) which come together in interaction in many different ways, and are more successful in dynamic organizations. Dynamic organizations are more appropriate for dealing with changes, especially as mentioned in contemporary time.

The term 'human resources' comprises many different recruitment processes, needed for efficient management of resources. It is the different procedures and processes through which systematic, transparent and professional employees are engaged in such a way that would best manage the knowledge, skills, aptitudes and personality characteristics, both in favour of the company as an individual. Various staff operations and processes are enabling us to integrate the individual goals and objectives of the organization, which in crisis is even more important.

SDEWES.2009.699

## **Sustainability Analysis of Solar Orbital Power**

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### **ABSTRACT**

After solar space power plants have been first proposed by Glaser the idea has been analysed in detail with a concise review of possibilities and prospects of power generation in space and has been accepted by the business community. Pacific Gas and Electric Company plans to buy 200 MW of orbital electricity from the year 2016. Analysis of thermal cycles and working fluids for power generation in space demonstrated that it is possible to obtain thermal efficiency 58-63% with Brayton cycle using diatomic gases.

Here we analyse the economic, environmental and social effects of electricity production in solar space power plants using the best existing technology. We analyse both photovoltaics and solar thermal reactors using either Brayton, Ericsson or Rankine thermal power cycle. We also analyse the option that power plants are built in a robotised factory on the Moon. The power plan could either be used for energy production on the Moon or launched from the Moon into a geostationary orbit. Some alternative possibilities for energy transfer to Earth are discussed as well.

SDEWES.2009.586

## **Sustainable Development and Happiness**

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### **ABSTRACT**

Scientific studies of happiness multiplied following the creation of world database of happiness by Veenhoven. It has been shown recently by Lyubomirsky and Sheldon, that the best way to achieve sustainable gains in happiness is to change the actions, and that this is more important than circumstances. A positive correlation between various measures of happiness and indicators of sustainable development has also been demonstrated.

We analyse interaction between happiness and sustainability in respect of the recent interconnected crises of economy, society, finances, energy, ethics and environmental sustainability. Within this model we tested correlations of different indicators, in particular between the indicators of the quality of life, value systems, financial stress, violence, environmental quality and energy use. We suggest possible solutions to these crises, which would simultaneously improve both happiness and environmental sustainability.

SDEWES.2009.658

## **The Interconnection of Problems and The Janus-face of Technology**

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### **ABSTRACT**

In the 90s of the last century, scientists were generally rather optimistic in their forecasts about the effects of information technology on resource consumption. “Everything will get smaller and thus more environmentally friendly” was the predominant opinion. But this euphoric attitude has today largely vanished. On the one hand, it turned out that the IT hardware, despite being increasingly small, has a large ecological rucksack. During production, large amounts of resources are needed. On the other hand, it became visible that even in those cases in which miniaturisation actually is correlated with a decrease of demand in resources, this efficiency gain is transformed into lower prices, stimulates consumption and thus indirectly causes an overall increase of resource consumption. This effect is called the Rebound Effect.

Scientists repeatedly believed that they had solved a problem by technological improvements but some time later it came back like a boomerang (therefore, the Rebound Effect is sometimes called boomerang effect).

Today, we have problems with the environmental impact of IT production, the energy use of IT hardware and with electronic waste. The paperless office did not have yet a breakthrough and even though we substitute travel by phone and video conferences, we tend to travel rather more.

The information society causes a shift of the workforce - this time from the industrial to the service sector. At the level of production, the information society might add to the industrial society and via positive feedback, industrial production increases. But further increase of the environmental burden (which is often a consequence of industrial production) might irreversibly damage the ecosystems on Earth. Obviously, we cannot rely on technology alone when trying to solve future problems. Technology will be a necessary but not a sufficient tool.

SDEWES.2009.669

## **The Possibilities to Influence Global Climate Change**

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### **ABSTRACT**

Although the current climate changes, we are observing now, are not the fastest in Earth history, they are except for some occasions of astronomic impacts and sudden Earth-plate movements the worse known. One cannot make a good estimation about current climate changes without accepting it as a consequence of the local changes and putting it as a homologous retail into the history of our planet.

We should therefore talk about local activities with all unavoidable consequences and precautions to be done to avoid disasters caused by climate change. Although the warnings about excessive warming are well founded, we will present some examples where oversimplified estimations about the true and most important causes of global climate change provide proposed remedies, which could be potentially very harmful.

An important example of such a challenge is in prevailing greenhouse numerical climate models, where the total screening of greenhouse gasses is usually correctly calculated, however meteorological data and the distribution of pollution are neglected. These influences and their relative importance will be analysed in detail and discussed.

## Special Session: Sustainability Strategies in Building Sector: Life Cycle Approaches, Methods and Tools

### SUMMARY

The building and construction sector is strategically important in Europe for social, economic and environmental reasons and plays therefore a significant role in sustainable development. Construction uses more raw materials than any other sector and buildings account for 42% of total EU final energy consumption. While the traditional approach focused on the energy consumption in the use phase of buildings, more recent strategies consider their whole life cycle, including the production of buildings materials and components and the building end of life, with the aim of minimizing the consumption of energy and natural resources. Moreover a recent European Commission communication to European parliament (COM(2008) 397 "Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan") aims to integrate a range of policy tools as eco-design strategies, eco-labels, Green Public Procurement procedures for influencing the supply and demand side of industrial production. A distinctive element in evaluating the life cycle impact of buildings is the need to maintain the appropriate relationship among the building level and the materials and components one. Papers which address sustainability strategies at material, product or building level adopting a life cycle perspective are welcome.

*Session organizer: Dr. Mario Tarantini, ENEA, Bologna, Italy*

*Mario Tarantini is senior researcher at the Italian National Agency for New Technology, Energy and the Environment (ENEA), one of the largest public research institution in Italy. Graduated in Mechanical Engineering, he has since worked in Energy Systems Department of ENEA and, more recently, in the Environment, Global change and Sustainable Development Department.*

*His area of expertise has been for more than 12 years environmental study and analysis of water, waste and production systems, with a special focus on life cycle assessment methods. His present research interests include development and application of life cycle thinking methodologies and tools to implement sustainability policies. He has been involved as task coordinator in a number of national and international research*

*projects on sustainability assessment of water, wastewater and waste management systems, as well as production systems (furniture, textile, buildings). On behalf of Italian Ministry of Environment he is actually coordinating a working group to define environmental criteria for Green Public Procurement of building materials and elements.*



SDEWES.2009.127

## **Green Public Procurement of Building Materials and Elements: a Life Cycle Approach**

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### **ABSTRACT**

Green Public Procurement (GPP) is defined as any public procurement procedure that includes environmental criteria in calls for tenders. It is one of the key elements of the European Union (EU) policy on Sustainable Consumption and Production (SCP).

To reduce the environmental impacts of the goods to be acquired by local Authorities and guarantee an appropriate response of the market it is essential to define scientifically based, shared and easily verifiable environmental criteria.

A particular category of goods are building materials and elements. To correctly evaluate their life cycle impact, it is necessary to take into account the use phase of the building in which these products are assembled. In Italy only limited activities have been since now undertaken on GPP of construction products, despite the diffusion of some building certification programs, which often include environmental criteria on materials and elements, and the availability of some Type III eco-labels (Environmental Product Declarations) of construction materials.

In this paper a case study on definition of GPP criteria for windows is presented. After a short description of the concepts of GPP, as well as the building certification programs that are diffused in Italy, the distinctive characteristics of the building materials and elements are discussed. The paper continues describing the activities which brought to define the environmental criteria for windows. Finally, the possibility to extend this approach to other building components is discussed and a methodology to develop GPP criteria for building materials and elements is outlined.

SDEWES.2009.316

## **Emission Reduction Potential of a Building Life Cycle**

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### **ABSTRACT**

Building energy use accounts for almost 50% of the total CO<sub>2</sub> emissions in the UK. Most of the research has focused on reducing the operational impact of buildings. However in recent years many studies have indicated the significance of embodied energy in different building types. This paper primarily focuses on illustrating the relative importance of operational and embodied energy in a flexible use light industrial warehouse. The building is chosen for the study as it is relatively easy to model and represents many commercial buildings in the UK. The total energy used by a building over its life is the sum of total embodied energy of the materials (including recurring energy), operational energy, and end of life impact.

A comprehensive life cycle study was carried out by conducting an inventory of all installed materials and material substitutions covering the building structure. Ecotect simulation was used to determine the energy consumption for the 25 years design life of the building. Optimizing the whole life emissions of the building requires critical investigations in embodied, operational, and end of life implications of various design options. The paper explains some challenging issues associated with building life-cycle emissions analysis and demonstrates its use in evaluating alternative design strategies for an energy efficient industrial warehouse. The results provide an insight to quantify the total amount of CO<sub>2</sub> emissions saved by changing the design specification (envelope) and material selection by modelling various life cycle phases of the building.

SDEWES.2009.512

## **Lca Evaluations Applied to Dfd Building Strategies**

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### **ABSTRACT**

The aim of the present study is to investigate how the use of Design for Disassembly (DfD) strategies and the choice of materials and connection systems will affect the environmental impact of the building, with reference to the actual tendency for components' demolition and substitution activities. These ones, particularly accelerated in the last years, in fact, seem to be responsible in a large part for the construction products' premature discharge together with the increment of refusal production and waste of resource consumption.

Life Cycle Assessment evaluations have been carried out with reference to the case study, in order to estimate which is the impact variation due to project choices characterized by a different adaptability content and recycling potential for employed materials and, therefore, different end of life chances. Therefore, it has been supposed, for the selected case study, that after a short lifetime (20 years) a change would be required in the assessment of the unit's distribution or in materials used due to user's requirements evolution or to the modification of the starting typological destination.

In such sense different end of life scenario have been hypothesized for the selected case, according to the capability of the original project to reply to this change: i) in the case of a not flexible project, it has been supposed the demolition of all components and reconstruction with new ones, with a recycling rate in accord to low's requirements; ii) if the disassembly option is allowed but it is not possible to reuse the removed materials, they are supposed to be recycled after the dismantling; iii) in the third option, under the hypothesis of a high adaptability content of the starting project, existing parts have been reused and reconfigured in the new required distribution. In the second case, particularly, recycled building products have been proposed for the second installation in order to understand how the impact could decrease thanks to the reduction in resource and energy consumption and in waste production. For all mentioned scenarios, LCA evaluations have been performed, in order to quantify the environmental performance of alternative strategies and to guide architects towards more sustainable project choices.

SDEWES.2009.518

## **Lca in Buildings: the Enslic Simplified Method and Guidelines**

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### **ABSTRACT**

The application of LCA in the building sector is generally scarce today. It has several causes. First of all, making a LCA evaluation of a whole building demands a specific tool to handle the large information needed. Further, this tool has to be adapted to the different decisions taken throughout the life cycle of a building. In a few countries such tools have been developed but they are exceptions. However, useful experience has been gained in these countries which is a valuable source for developing guidelines for application in other countries. Different LCA tools for the building sector contain common but also different indicators or indicators calculated in different ways. A harmonisation of both calculation and presentation of LCA results would simplify and promote further application. General guidelines for application and a core of recommended indicators have been developed and explained in this paper.

The methodology and guidelines presented is a systematic approach guiding the user through the Life Cycle process - clarifying issues which usually cause difficulty and supporting the user through the alternative options regarding choice of software- their strengths and weaknesses, databases available, usefulness of different indicators, aggregation and results presentation, definition of limits, options for simplifying the process and the consequences for later integrity of the study's results. To overcome difficulties to make preliminary LCA calculations for comparison of basic design alternatives in early stages, guidelines to treat this problem are summarized and recommendations developed. Recommendations on how to prioritise and treat lack of qualitatively acceptable input data have been included as well.

The simplified method has been developed in the framework of the 'ENSLIC building project', co-financed by the European Commission-Intelligent Energy for Europe Programme- by nine European Organisations and more tha

SDEWES.2009.528

## **Life Cycle Design of Building Elements: Selection Criteria and Case Study Application**

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### **ABSTRACT**

In the last years there has been a multiplication of the International and European political interventions addressed to diffusion of environmental sustainability in the building sector. In this area the life cycle design of technical elements assumed particular relevance. The materials and construction techniques used, like their durability in use phase and their disposal strategies, tend to influence the environmental behaviour of a building during its whole life cycle.

It is worth recalling the energy consumption connected with the extraction, production and assembly of the materials (initial embodied energy) and with maintenance, replacement, and dismantling activities (lifecycle-embodied energy). Or the environmental impacts produced by materials, that represent about 25% of the overall impact of the building. At the present time the rules focusing on the environmental certification of technical elements allow to meet these objectives only in part.

The study that will be presented, based on eco-design and Life Cycle Assessment criteria, start to this knowledge to explain a research work focused on a comparative evaluation of some technical elements, of which also suggests a possible technological classification.

SDEWES.2009.520

## **A Swedish Environmental Rating Tool for Buildings**

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### **ABSTRACT**

In 2003, an agreement was signed by the Swedish government, a number of companies in the building and construction sectors, some municipalities, insurance companies and banks. In this agreement a target was set that by 2009, all new buildings and 30% of existing buildings should be rated using a voluntary environmental rating tool. A major research programme was launched to develop a tool that could be used in this context. The programme (finished in April 2008) involved several Swedish research institutes, and was sponsored by approximately 30 companies, organisations and funding agencies. The rating tool was developed in a joint effort covering both numerous tests of the tool on real buildings and a great number of interviews with different stakeholders at several stages of the project.

Important starting points for the tool construction, as expressed by interviewed stakeholders, included simplicity, credibility, make use of earlier national and international experiences, transparency, close relation to national goals and permeated by a life cycle perspective. The tool covers three assessment areas: Energy, Indoor environment and Chemicals. These areas are split into 11 aspects with one or a couple of indicators. Rating criteria are specified for each indicator, stipulating requirements for a rating A, B, C and D, where A represents the best performance. The indicators thus form the basis for the rating tool. Indicator results can then be aggregated to aspect, area and a single rating for building level for enhanced result communication. A number of properties of this tool makes it unique if compared to well-known tools like LEED, BREEAM, etc. It includes few indicators and is therefore simple but focused on the most significant building-related environmental aspects. It avoids weighting of different environmental aspects and therefore omits 'points-chasing'. It is to a large extent performance-based and therefore stimulates technical innovation rather than prescribing specific solutions. Finally, it is general for all types of buildings.

A number of developers of new buildings and managers of existing buildings have already started to use the tool. An independent stakeholder group under the Swedish National Board for Housing, Building and Planning are currently driving and investigating important tasks for the broader implementation such as responsible organisation and the development of economic incentives to be connected to the tool.

## Special Session: Converting Biomass and Wastes into Green Fuels by Modular Thermochemical systems

### SUMMARY

Decentralized electricity production is likely to play an important role in future energy supply. Facilities utilizing indigenous renewable sources and designed to supply local communities and decentralized energy users are in the forefront of EU energy and environmental policies. Especially small-scale biomass installations, producing electrical and thermal power appear to be among the most promising technologies for decentralized energy generation.

The small and medium scale applications especially for decentralised CHP in rural locations are of great importance due to several benefits that could be obtained such as:

- support of agricultural and forestry sector by providing solutions for additional income for farmers and forest managers,
- ecological impact reduction of biomass routes (water and soil protection, biodiversity, air quality etc),
- increase in the share of biogenous fuels within the energy market,
- reduction of fossil fuel energy use and substitute imported energy flow.

Gasification/pyrolysis of agricultural residue can be effectively combined with various power units to generate electricity and this at a small scale. A gasifier coupled with an internal combustion engine (ICE) provides the opportunity of high-performance electricity production in small and medium scale installations (up to 35%). Increased efficiencies and decreased capital costs could be obtained in the case of solid biomass feedstock conversion into gaseous fuel able to be used in ICE.

The link-up of biomass gasification with high temperature fuel cells, such as solid oxide fuel cells (SOFC) is a promising approach to reach high electrical efficiencies in small scale combined heat and power plants (CHP). This combination is referred to as "Biomass – Integrated Gasification Fuel Cell System" (B-IGFC). The main technical challenge



is the adjustment of the three main system components gasification, gas processing and fuel cell.

The session is open for presentation of studies, projects and plans of small mobile or stationary decentralised biomass and waste integrated Energy Systems and welcomes technical studies of system design as well as social science studies of how to implement such technological systems.

Session organizer: **Prof. Anastasia Zabaniotou**, Aristotle University of  
Thessaloniki, Thessaloniki, Greece

*Anastasia Zabaniotou is Associate Professor at the Chemical Engineering Department of Faculty of Engineering at the Aristotle University of Thessaloniki in Greece. She is Board member of the Centre for Sustainable Development of the Aristotle University and participates in the Network of Mediterranean Engineering Faculties for Sustainable Development. Dr. Zabaniotou holds Ph.D. from Ecole Centrale de Paris and has been working for 4 years in the European Commission of EU in DG Research. Prof. Zabaniotou is active in thermochemical conversion of biomass and waste for energy, biofuels and materials production. She develops research in the field of bioenergy, biofuels, bio-hydrogen, second and third generation biofuels production, design of small modular mobile gasification/pyrolysis systems integrated with engines and fuel cells, modelling and process integration. She has been involved in a number of national and international research projects and international networks. She is author and co-author of more than 50 papers in international journals and 80 conference presentations, she is a reviewer of several international journals and evaluator of EU and international projects.*

SDEWES.2009.398

## **Temperature Effect on Hydrotreating of Used Cooking Oil**

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### **ABSTRACT**

Hydrotreating of vegetable oils is a prominent technology for the production of biofuels, with recent industrial applications. This work focuses on the application of hydrotreating to used-cooking oil feedstock, collected from local restaurants and homes. In this work the effect of reaction temperature is studied as it is one of the key parameters affecting hydrotreating effectiveness. Three reaction temperatures were studied (310°, 330° and 350°C). The results indicate that there is an optimal/maximum temperature affecting hydrotreating in terms of biofuels quality and biodiesel yield. Heteroatom (mainly S, N) improves with increasing temperature while oxygen removal exhibits a maximum at 330°C. Finally saturation is also maximized at the middle reaction temperature.

SDEWES.2009.482

## **Energy Potential from Coconut and Palm Oil Residues**

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### **ABSTRACT**

Agricultural residues continue to attract interest for energy recovery purposes as a renewable, CO<sub>2</sub> neutral and increasingly cost competitive alternative to traditional fossil fuels. The possibility of trigeneration in already established industries such palm oil mills and coconut processing plants is very attractive especially when residues that otherwise represent a disposal problem can be utilized efficiently.

The use of these residues in rural areas or in small islands could certainly represent an advantage as the use of expensive fossil fuels represents an additional burden to foster development. Different technical scenarios for the production of electricity, process heat and biodiesel are analyzed using these residues. Environmental aspects are also included in this analysis.

Studies were done considering certain scenarios to evaluate the feasibility of using these residues for energy purposes. Residues were considered to be combusted directly in boilers and steam turbines were used as prime movers to generate electricity. Biodiesel is produced by transesterification of palm oil/coconut oil. The required process heat for palm oil or coconut oil processing is supplied by the residues as well as the steam required for biodiesel production. The advantage is that biodiesel is a more flexible and easy-to-distribute fuel that can be used for power generation or for transportation. The results shown that palm oil mills/coconut processing industries can be independent of fossil fuels. Furthermore, they can contribute positively to the energy balance of the communities by helping reduce the dependence on fossil fuels and reducing at the same time greenhouse gas emissions.

SDEWES.2009.552

## **Novel Catalytic Systems for The Purification of Syngas from Tars Produced in Biomass Gasification**

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### **ABSTRACT**

Biomass is CO<sub>2</sub> neutral, abundantly available, and it is considered as the only carbon-containing source among many other renewable energy sources with a strong potential to be a good starting material for the production of liquid fuels, chemicals, and hydrogen. The catalytic steam and/or air/steam gasification of biomass appears to be an attractive process for the production of a hydrogen-rich product gas. However, the presence of *tars* is still a significant impediment for the production of a clean gas for further processing. *In situ* gas purification and upgrade of the raw syngas is one of the major issues and challenges related to practical biomass gasification applications. Phenol has been identified as one of the main constituent molecules of tar formed after gasification of wood-biomass. Supported nickel catalysts are the widely used industrial catalysts for gasification/reforming reactions of aromatic compounds. However, toxicity and high built-up of surface carbon deposits on supported-Ni catalysts necessitates the development of new and low-cost catalytic materials being active at temperatures as low as possible (e.g. T<550°C).

The present work is focused on the development of new catalytic materials for the steam reforming of phenol towards CO, CO<sub>2</sub> and H<sub>2</sub> in the 350-550°C *low-temperature range*. These materials consist of Rh (0.5 wt%) supported on commercial mixed metal oxides of Ce-Zr-Mg-O. The catalysts were characterized for their texture, structure, re-dox and Rh dispersion by BET, X-Ray Diffraction, H<sub>2</sub> temperature-programmed reduction, and H<sub>2</sub> chemisorption, respectively. CO<sub>2</sub> and CO temperature-programmed desorption and DRIFTS-CO chemisorption studies were also conducted for an in-depth study of CO and CO<sub>2</sub> reaction products interaction with the catalyst surface. Catalytic steam reforming of phenol over low loading Rh-supported catalysts at *low reaction temperatures* has not yet been reported.

SDEWES.2009.242

## **Sustainable Energy Production by Agro-residues in a Modular Fluidized Bed Gasifier**

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### **ABSTRACT**

Gasification technology offers the ability of producing fuel gas from solid or liquid biomass. The gas can consecutively be energetically exploited or used to develop value - added products. Gas heating value utilization is accomplished through various applications, such as direct combustion of the gas in combustion chambers and IC engines or as feed in fuel cells in order to produce heat and / or electric energy. The efficiency and viability of gasification applications depend mainly on the gas quality, regarding its energy content and pollutant load. The process conditions in the reactor are a determinant for optimized gas quality production.

A pilot scale reactor was constructed, which aimed at the research of fluidized bed biomass gasification. The gas produced would be exploited in an IC engine. Atmospheric air was used as an oxidant and olive kernels were selected as biomass feed. A variety of air to fuel ratios and reactor temperatures between 750 - 900°C were tested. The purpose of this study is the presentation of the pilot scale reactor and the effect of crucial gasification conditions on gas quality. Finally, a comparison concerning gas composition was held between experimental and computational results.

## Special Session: Storage Requirements for a 100% Energy Supply

### SUMMARY

In countries with ambitious targets concerning the integration of renewable energies into their supplies the limits of integration are on the agenda of every scientific and political discussion. Apart from the finiteness of fossil and nuclear energy sources and environmental necessities the substantial integration of renewable energies targets the interests of energy industry that has been grown for more than a century. It is generally accepted that there are limits of intermittent energy resources like wind energy and photovoltaics in an electricity system. That is argued by stability reasons of integrated electricity networks and by the nature of electricity that cannot be stored in quantities needed in our today's energy systems.

But decoupling of electricity generation and electricity consumption cannot only be done by electricity storage! And energy management cannot only be done on the supply side! In this session concepts for realization of 100% energy supplies are discussed as well as progresses in energy storage technologies and ways to avoid energy storage by intelligent energy management strategies.

Session organizer: **Prof. Ingo Stadler**, Cologne University of Applied Sciences, Cologne, Germany

*Dr. Stadler is managing director of the Institute for Electrical Power Engineering of Cologne University of Applied Sciences. Within in the institute he covers the areas of renewable energies and energy economics. Dr. Stadler is working since many years with the topic of electricity supply systems with high fractions of renewable energies. Among others he investigates demand response activities and non-electric energy storage devices in order to decouple electricity generation and consumption. In the European project "Dissemination Strategy on Electricity Balancing for Large Scale Integration of Renewable Energy (DESIRE)" it was investigated how fluctuating renewable energies can be balanced with CHP and thermal energy stores. Dr. Stadler co-ordinated the work package "Short-term solutions and long-term perspectives" - the technological side of the project. Within the second grid study of the German energy agency (dena II) it will be investigated on how high fractions of renewable energies can be integrated into the electricity supplies by energy storage and demand side activities. Within that project Dr.*

*Stadler takes care about transition to a flexible demand side and integration of thermal stores in order to improve flexible electricity generation. Additionally, Dr. Stadler has been German's expert for "Stand-alone and Island Applications" in the Photovoltaics Power System Program of the International Energy Agency (IEA) for a period of ten years. Here he dealt with electricity supply of communities that are not connected to the public grid.*

SDEWES.2009.377

## **Integration of Demand Side Management, Distributed Generation, Renewable Energy Sources and Energy Storages**

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### **ABSTRACT**

Energy policies are promoting distributed energy resources such as energy efficiency, distributed generation (DG), energy storage devices, and renewable energy resources (RES), increasing the number of DG installations and especially variable output (only partly controllable) sources like wind power, solar, small hydro and combined heat and power. This kind of generation can cause problems in grids, in physical balances and in adequacy of power.

Thus, there are two goals for integrating distributed energy resources locally and globally: network management point of view and energy market objectives.

Solutions to decrease the problems caused by the variable output of intermittent resources are to add energy storages into the system, create more flexibility on the supply side to mitigate supply intermittency and load variation, and to increase flexibility in electricity consumption. Combining the different characteristics of these resources is essential in increasing the value of distributed energy resources in the bulk power system and in the energy market.

Successful integration means that different technologies in supply and demand side as well as in ICT are developed to the level where their integration is feasible both technically and economically and that regulation, policy and market give the successful framework for the integration.

The paper is mainly presenting intermediate findings of the IEA DSM Agreement Task XVII where knowledge from several participating countries are collected and analysed. The main topics discussed are DER and electricity supply, flexibility in electricity demand, communications and IT, integration analytics, regulation, policy and business opportunities as well as market in participating countries.

In addition to that some aspects of the possibilities of aggregation business (demand and/or DG aggregation) to promote the integration are discussed on the basis of some European projects.



SDEWES.2009.505

## **Sustainability of Rural Electrification Approach Using Solar Photovoltaic Systems in Nepal**

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### **ABSTRACT**

New developments in the field of energy generation and distribution, energy efficiency, environmentally friendly technologies, and renewable resources are discussed in almost every scientific or political meeting related with sustainable development in recent years. Limited reserves of fossil fuel resources, their volatile and increasing price in the energy market, emission of several environment hazardous substances by their burning are the reasons why sustainable and environment friendly alternatives to fossil fuels have to be sought urgent.

Historically, Nepal's rural population has been meeting their energy needs from traditional sources like fuel wood and other biomass resources. Although Nepal's topography gives her an enormous potential (theoretically 83 GW) for hydroelectricity generation, only less than 0.7 GW has been produced because of political and economic situation of the country. Only about 40% of the total population has access to electricity, though not reliable, since there is a power cut off up to 16 hours a day in winter 2008-09. Because of the country's dependence on imported fossil fuels, the high cost of grid connection and low and scattered population density, a decentralized energy supply system becomes the natural choice. Distributed generation of electricity at the consumer's site using environment friendly solar photovoltaic technology might be one of the best solutions to overcome these problems. So far more than 100000 solar home systems have been installed throughout the country supported with subsidy schemes.

This paper discusses the possibility of further spread of solar home systems in Nepal. Government policy on these systems will also be discussed. Since the solar module price is decreasing every year significantly in world market, this might lead to economically feasible solar home systems even if the subsidy scheme is stopped one day. Such economic analysis will be carried out and a comparison of a kWh end user's electricity price from PV with other means of electricity supply systems, e.g. grid extension, will also be made.

SDEWES.2009.569

## **The Role of Power Electronics in The Development of Distributed Energy Resources Towards a Fully-renewable Energy Supply**

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### **ABSTRACT**

Power electronics already play a significant role in the current electrical energy supply structure. They are the power conditioning unit for excellence in technologies such as PV, they provide a considerable flexibility to current power transmission and distribution system through FACTS and they are able to bring storage technologies such as batteries or fuel cells to the grid.

Among the strongest features of power electronics is its flexibility. Unlike conventional machine-based generators, inverter-based ones are able to react differently to the same event depending on the control program. Inverters may act as controlled current sources or as voltage sources connected through a coupling impedance, whichever is required.

The objective of this work is to present an overview of the main characteristics of inverters, their potentials and the importance of their role in the next-generation network that could support a 100% renewable energy solution.

The paper is divided in four main sections:

- + An overview of the characteristics of power electronics converters
- + An analysis of several projects working with topics related to the integration of power electronics in the grid.
- + The role of power electronics in the next-generation grid and
- + An outlook and overview of some projects that work towards a 100% energy supply with renewable energy.

A local, and in some cases regional supply which contain 100% renewable energy has been shown to be possible. In these cases power electronics play a major role not only in the area of power generation but also in terms of network services and control.

SDEWES.2009.614

## **Investigating Renewable Energy in Egypt to Address Energy Situation Challenges and Future Plans**

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### **ABSTRACT**

This paper summarizes the energy situation in Egypt starting with the energy management system. The study has extended to the renewable energy and energy efficiency potentials in addition to energy indicators which cover economic, environmental and social aspects. It has also investigated the electricity sector, its reformation, and its origin. The, some set of energy indicators have been shown which give a good picture of a country's energy system. A set of performance indicators is analyzed together with the implementation of the national strategy measures aimed at reducing green house gas emissions. Some selected results from environmental analysis are given. The indicators are used as a measure of the overall performance relative to targets and benchmarks for past and future projections up to year 2020. The potential performance indicators for energy sector include: fossil fuel consumption (primary energy), greenhouse gas emissions from energy sector, energy related greenhouse gas emissions per unit of energy delivered, energy related greenhouse gas emission per unit GDP, and energy related greenhouse gas emission per capita. The selected indicators are used to measure progress towards sustainable development in the country.

SDEWES.2009.649

## **Integrating Renewable Energies - Long Term Technical and Economic Potential for Demand Side Management from Energy Intensive Industries in Spot and Balancing Electricity Markets**

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### **ABSTRACT**

The paper aims to investigate technical and economic potentials of energy intensive industries to provide demand side management in electricity and balancing markets up to 2030. In the coming decades Germany (as well as other European countries) faces a strong shift towards renewable electricity generation. During this time the share of renewables rises from 10% to 26% , primarily driven by an increase in wind capacities. A significant share of wind generation and other renewables with volatile electricity feed-in will have price effects in the spot market and lead to a growing demand for positive and negative balancing power. Demand side management (DSM), thus the active participation of endconsumers in the electricity markets, can increase market efficiency and reduce overall costs for electricity procurement. Energy intensive industries provide a significant share for potential DSM applications.

This paper aims to determine to what extent DSM from industrial processes can provide economic benefits in an electricity market with renewables. Different industrial processes and its specific technical and economic properties are investigated and compared to other storage devices and plant technologies. The simulations are based on an extension of the European electricity market model DIME. The model is based on linear optimisation and allows to determine long-term forecasts for market prices, dispatch and investments in the electricity markets.

SDEWES.2009.570

## **Application of Smartgrid Concept to Mediterranean Islands: Challenges and Perspectives**

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### **ABSTRACT**

The world of energy is facing a great deal of challenges, including reducing emissions, making use of renewable energy sources and reducing dependence on fossil fuels. The situation in Europe is even more critical due to its dependence on foreign supply of fuel. A solution can be a drastic reduction of the consumption but with an aging power infrastructure and an increasing number of electricity-hungry devices, this solution is difficult to achieve. As an alternative, the current energy infrastructure can be transformed and enhanced in such a way that enables it to operate in a more efficient and effective way.

This is the vision of several emerging concepts such as Smartgrids, GridWise, Intelligrid or Modern Grid: To create the next-generation electrical-energy supply network: the smart-grid. While the vision that smart-grid encompass is well defined, the means and key concepts required to achieve it are not yet at a mature state. In Europe, the smart-grid concept defined by the SmartGrids technology platform is the most accepted one by the government, industry and the scientific community and thus this work focuses on it.

Isolated power systems have an intrinsic weakness due to its low system inertia which results in large frequency excursions and therefore instability risk. An added problem is the low short-circuit power in the transmission nodes of this type of systems, which give information about their high grade of vulnerability to several fault and contingency scenarios. Therefore, in order to achieve a similar performance than large interconnected systems (such as the European UCTE), isolated systems must

provide superior primary and secondary reserves and must increase protection schemes at transmission levels, which are not required in larger systems (e.g. 66 kV and 132 kV). Furthermore, isolated systems have the necessity of having more robust substations. All these requirements translate into increased costs and complexity for the system, which despite the measures could be driven to a total blackout easier than an interconnected system like the UCTE.

This paper will focus on analysing the application of the SmartGrid concept for increasing the penetration of Renewable Energy Sources and Distributed Generation on Middle Sized Isolated Power Systems, tailoring the application of this concept to the needs of those special power systems. The study will be applied to the Balearic Islands power system.

## Biomass, Biogas and Biofuels: Potentials and Limitations I

SDEWES.2009.104

### **Biofuels Versus Food Production: Does Biofuels Production Increase Food Prices?**

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#### ABSTRACT

Rapidly growing fossil energy consumption in the transport sector in the last two centuries caused problems regarding greenhouse gas emissions, energy dependency and supply security. These problems could be reduced by using biofuels. Currently first generation biofuels - bioethanol and biodiesel - are the most widely used. The production of biofuels is relatively small in almost all countries with the exceptions of USA and Brazil. The largest shares of biofuels in total transport fuels in 2007 were about 21% in Brazil, 3% in the USA and less than 2% in the EU. To increase these shares, many countries worldwide have set targets for biofuels. In the European Union by the year 2010 5.75 percent of the energy used for transportation should be biofuels.

Preferred feedstocks for biofuels production are corn, wheat, sugar cane, soybean, rapeseed, sunflowers. The problem is that these feedstocks are also used for food and feed production. The rapidly growing world population and raising energy consumption caused increasing demand for both, food and fuels. According to the World Health Organization more than 3.7 billion people are currently malnourished and that number is continuously increasing. At the same time, grain production per capita worldwide is declining.

According to a study the World Bank the production of biofuels is pushing up food prices. Between 2005 and 2008, corn prices almost tripled, wheat price increased by 127% and rice price by 170%. Although, in period from 1971 to 1973 there was no significant biofuels use, corn and wheat prices went up by a factor of 3, because of oil crisis.

The core objective of this paper is to investigate the impacts of biofuels production on food production looking at Brazil, the USA and the EU. The most important factors to be analysed are: (i) available land potentials: Biofuels potential is very dependent on land availability, crop yields, as well as food demand; (ii) the impact of different biofuels promotion policies and targets.

Our preliminary results are: In the Business-as-Usual Scenario, based on the assumption that biofuels are produced only from conventional crops, about 13.8% in the EU-25, in the USA 9% and in Brazil 12% of total potential crop land area will be

necessary for biofuels production until 2030, without causing significant problems for food production.

The major conclusions of this analysis are: (i) over the longest period of history feedstock was the major energy source for transport and it was possible to satisfy food and fuel production in a sustainable manner (ii) biofuels, especially 2<sup>nd</sup> generation biofuels, can provide a remarkable contribution to transport in the near future and contribute to GHG reduction. But even if all crops, forests and grass lands currently not used were used for biofuels production it would be impossible to substitute all fossil fuels used today in transport; (iii) A co-existence of biofuel and food production is possible especially for 2<sup>nd</sup> generation biofuels; (iv) Yet, to finally bring about a sustainable transport system significant increases in efficiency especially in motorized passenger transport as well as a change in transport modes towards more environmentally benign ones are strongly required.

SDEWES.2009.434

## **Biogas Potential in Croatian Farming Sector**

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### **ABSTRACT**

Farming sector, in general, is a big producer of manure and thereby also a big producer of greenhouse gasses. The issue of methane production from animals on farms should be seen as an opportunity in producing green energy and contributing into reducing green house effect. Croatian farming sector is pretty undeveloped if we compare it to the other EU member states. This is one of the legacies from past state where agriculture was not something worth of heavy investments. This was not only the case for Croatian farming sector, but also Croatian agriculture in general for the last twenty or more years. However in the last five years there were a lot of improvements and investments in agriculture and in the farming sector. More and more questions regarding energy issues and energy management on farms are becoming important. But this is still not enough if we want to use all of our resources and potentials. If we consider the fact that there are more than 24200 pig farms in Croatia and over 240000 dairy cows alone it is obviously that there is a big potential for biogas production. Especially if we consider the fact that there is no serious biogas plant in Croatia yet. All of this information with a promising increase in agricultural investing leads us to a question of total biogas potential for the farming sector in Croatia. Through this paper we will show the total number of farms and their potential for producing, storing or using biogas. The main challenges would be to separate small family farms that basically have no biogas potential and bigger modern farms that could be considered for biogas production. One other concept would be the possibility of gathering farms for joint biogas production but for this scenario special calculation should be made taking into consideration economic viability and distances between farms. The value of finding Croatian s biogas potential regarding farms is also important since farms are consuming a lot of energy in their everyday operations: water heaters, milk coolers, vacuum pumps, lighting, irrigation pumps, fodder dryers, ventilation etc. A lot of this energy consumption can be compensated from renewable energy source like biogas. This is also one of the aspects of this research. In this case primary focus is on electrical energy that could be produced from burning biogas in an engine but also heat energy that could be produced in this process.



SDEWES.2009.558

## **How Much Hope Should We Have for Biofuels?**

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### **ABSTRACT**

High and volatile oil prices and growing concerns on climate change and energy security led to significant expansion of biofuels in many countries around the world over the last few years. Several countries have introduced mandates and targets for biofuel expansion. Investment on biofuel industry has sharply increased. However, the increased production has raised some concerns. The swift escalation of food prices in 2007 and 2008 created a food crisis that resulted in riots in many parts of the world, inducing some observers to point to the diversion of food crops to biofuel production as the cause of the crisis. The expansion of biofuel production has also raised demand for feedstock, enlarged or intensified cultivation of which can have serious consequences for biodiversity, soils, as well as water supply and quality. These issues have curbed the enthusiasm for rapid growth of the first generation biofuels. However, the developments in second generation biofuels, which do not directly compete with food supply and that can be cultivated in low quality lands, may offer some hope. This paper first examines the recent trends on biofuel production, consumption and trade patterns, followed by various impacts of biofuels including those on land use, food security, energy security, climate change mitigation, economic growth and poverty. Finally, we investigate the prospects of second generation biofuel technologies.

SDEWES.2009.212

**Biogas in Portugal: Status and Public Policies**M. F. L. Ferreira<sup>1</sup>, I. Malico<sup>1</sup>, I. P. Marques<sup>\*2</sup>

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<sup>1</sup> University of Évora, Department of Physics, Portugal<sup>2</sup> LNEG-Laboratório Nacional de Energia e Geologia, I.P., Unidade de Bioenergia, Portugal**ABSTRACT**

Portugal has recently implemented a number of measures and monitoring mechanisms that seek to promote renewable energy sources as a way of protecting the environment and assuring a sustainable development. In its policy for renewable energies, 39% of the electricity from renewable energy sources was defined as target for 2010. Biogas arises as a useful energy source by its direct conversion into heat and electricity or by injection into a natural gas network. This work reviews the Portuguese public policies on biogas, the current status of biogas production and its potential implementation as a relevant energy source.

In Portugal, over the last decade there has been a big growth of the biogas produced from anaerobic digestion, both in electricity production (67 GWh in 2008) and installed power (12.4 MW in 2008). However, the current installed capacity and energy produced from this renewable source does not reflect its huge potential.

SDEWES.2009.618

## **Assessing Direct Land Use Change in Rapeseed Oil GHG Emissions: a Life Cycle Model Accounting for Uncertainty**

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### **ABSTRACT**

This article addresses different land use change scenarios, as well as uncertainty issues related to parameters and concerning how co-product credits are accounted for, in the life cycle modeling of rapeseed oil (RO). In particular, a comprehensive assessment of different land use change scenarios – rapeseed cultivation in former agricultural land, set-aside land and grassland – has been conducted, which results in different carbon stock change values. GHG emissions of RO and GHG savings relative to fossil diesel have been calculated in terms of probability distributions using a substitution method, three allocation approaches and ignoring co-product credits. The net GHG balance of rapeseed oil is strongly influenced by soil carbon stock variations due to land use change and by the magnitude of nitrous oxide emissions from cultivated soil. Depending on prior land use, GHG emissions may comply with the European directive's target of 35% GHG emission savings (arable land and set-aside land converted to rapeseed cultivation) or, conversely, may completely offset carbon gains attributed to rapeseed oil production for several decades (conversion of grassland; substitution method).

## Advances in Waste Management I

SDEWES.2009.033

### **Who Loves Sewage? Matching Expectations on Communication Between Households and Sanitation Professionals**

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#### **ABSTRACT**

As a consequence of the ambition to increase sustainability within the urban sewage system in Sweden, municipal sanitation professionals increasingly address the roles and responsibilities of households. Different tools are used to communicate with households concerning their use of the sanitation system. The aim is often to inform about desired types of household chemicals or unsuitable products in the sewers. Communication tools are developed according to the professionals' expectations on the households' level of engagement and knowledge. In households, on the other hand, individuals express their concern through practical activities with consequences for the sanitation system, including washing, dish washing and cleaning. Their daily routines are also developed with respect to their expectations on convenience and trust for the treatment facilities. In this study, the aim was to relate the views on communication within these two groups of actors; sanitation professionals and households. What do the professionals expect from households? In what ways do they communicate their expectations? What do households expect from the professionals and the sanitation system? How do they regard the communication strategies? It was found in previous studies that design and function of the infrastructure system to a large extent take part in shaping relations between different groups of actors. It is therefore interesting to see how the professionals and households manage to act and communicate within or on the borders of the existing sanitation system. Two strategies are studied; one case of alteration of the technical features in the households, and one case of intensive, location specific information to households using the conventional system. In each case, female and male household members as well as sanitation professionals were interviewed in focus groups. The questions covered communication strategies, expectations on the other group, concern for (ecological) sustainability etc.

SDEWES.2009.186

## **Msw Incineration Plant Siting Applying GIS and Multi-criteria Analysis**

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### **ABSTRACT**

The preservation of adequate air quality is presently mandatory for a sustainable development. Additionally, legislation on pollutant emissions is becoming increasingly restrictive as it imposes stringent limit values on emissions. In fact, an ill-defined location of new incineration plant may result in strong adverse impact from its operation on local communities and contribute to degradation of the environment. Therefore, integration of environmental impact assessment in the phase of a municipal solid waste incineration plant (MSWIP) site selection has to be of the great concern to guarantee that any associated adverse impact is minimum. Siting a new MSWIP requires an extensive evaluation process in order to identify the best available location that simultaneously meets the requirements of government regulations and better minimises negative impacts. It is a very complex process requiring political decisions based on technical, economic, environmental, health, and social issues since, on one side, multiple and even contradictory objectives may be involved and, on the other, multiple alternatives are available. A spatial multi-criteria evaluation methodology is presented herein to optimally site MSWIP. It is demonstrated with its application to a Cape Verde island. The new methodology combines the analytic hierarchy process to estimate the relative importance weights of the evaluation criteria with GIS, identifying and ranking potential areas according to their suitability. The evaluation criteria cover socio-economic, technical and environmental aspects, among others, transportation costs, proximity to urban centres, land use, morphology, and environmental impact due to the plant operation. The results confirm that the proposed method possesses capacity and flexibility to be applied in any region. It provides the decision makers with important and information in the assessment of the waste management problem including the sensitive environmental impact issue.

SDEWES.2009.390

## **Managing and Hedging Fuel Supply for Waste to Energy Facilities**

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### **ABSTRACT**

Thermal decomposition of solid and liquid waste has long and turbulent history and legacy. From backyard burning, via larger scale uncontrolled incineration (including its offshore variant), it acquired a reputation as a irresponsible way of waste disposal, where the pollutants went literally up in smoke, destroying the evidence along the process. Contemporary processes of thermal waste decomposition have gone a long way towards creating clean waste disposal option with pollutant levels way below the established emission limits. This is particularly the case with several emerging plasma treatment technologies that produce essentially clean combustible gas and a vitrified immobilized slag as a solid residue.

One perennial problem remains, though. The investment in the waste to energy facility creates the need for steady supply stream of suitable, combustible waste. Even when the process is proven as clean and energy efficient, the danger of 'tail wagging the dog' of waste management threatens to hamper future advances in the three 'R-s' (reducing, reusing and recycling). Clearly, if the future options of waste stream reduction are kept open, the investment risk in building high quality facility need to be managed in some other way. Matovic (1999) proposed a multifaceted structure of the waste-to-energy system combining natural gas and MSW as fuels. A sustainable alternative is to use a combination of biomass and waste as its input fuel. The use of biomass in Canada is still in its infancy, as well as the waste-to-energy conversion. Currently landfilling contributes 2.9% to Canada's total greenhouse emissions, indicating large potential for greenhouse gas reduction.

The paper will suggest durable balancing scenario for combined biomass/MSW (municipal solid waste) facilities, using either classical combustion, plasma incineration or gasification as the options.

SDEWES.2009.439

## **High Calcium Ashes Management. An Holistic Approach**

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### **ABSTRACT**

The application rate of Hellenic High Calcium Ashes (HCA) is still very low compared with similar European ashes. This fact must be attributed either to the lack of development of a holistic management system in Greece or to their particularities due to their intrinsic characteristics. These characteristics exclude generally Hellenic High Calcium Fly Ashes from the relevant European Standard (EN 450-1) even though numerous literature findings clearly demonstrate that selected qualities of theme provide better durability properties than LCFA and consequently can be used in special concrete applications. In the frame of this paper are discussed the disadvantages of Hellenic HCA as well tested beneficiation techniques which are necessary for the treatment of ashes order to meet the specifications of EN 450-1 or existing National Norms.

SDEWES.2009.240

## **Application of Pyrolysis for Treatment and Utilization of Difficult Wastes**

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### **ABSTRACT**

Pyrolysis is a thermal process carried out with the exclusion of oxygen. Most organic macromolecules are decomposing to gas, oil and char in the temperature range of 300°C - 600°C under an inert atmosphere. Accordingly solid waste composed of either natural or synthetic organic material can be thermally treated in order to obtain valuable products such as energy rich oil, important chemicals or carbonaceous adsorbent. The proportion of gas, oil and char among pyrolysis products of various wastes depends primarily on the chemical nature of the material and can be influenced by the temperature and other conditions of pyrolysis. Pyrolysis oil and char are the main products of biomass waste in agriculture and of plastics waste. This technique is adaptable for chemical plants of various scales from local small device to large industrial factory.

In this lecture the advantage of pyrolysis technique is demonstrated for the exploitation of complex wastes such as agricultural by products and waste electronic and electric equipments (WEEE). Pyrolysis oils of various biomass wastes have similar chemical composition because of the similar plant constituents in wood, straw, husk, stone, and other kind of biomass. In this way the disadvantageous properties of biomass oils such as acidic nature and instability can be handled in a similar way. On the contrary, plastics components of WEEE are rather versatile and this waste may contain smaller molecular organic compound additives as well. Thus the chemical composition of WEEE derived pyrolysis oils may be quite dissimilar. Fortunately pyrolysis technique can be easily coupled to catalytic conversion of the liquid products that makes possible to eliminate or convert the unwanted compounds in the oil with the help of low cost catalysts.

Laboratory experiments proved that it is possible to eliminate the chemically reactive components of biomass pyrolysis oil over suitable solid catalyst. In the case electronic plastics waste the dehalogenating activity of common catalysts was verified for various types of halogen-organic compounds. With the help of denitrogenating catalysts pyrolysis oils of polyamides, polyurethanes and acrylonitrile-styrene copolymers could be converted in to nitrogen free oil coping with the utilization of energy content of the nitrogen-containing plastics without NO<sub>x</sub> emission under combustion.



## Developments in Solar Photovoltaic Energy Conversion

SDEWES.2009.038

### Decreasing Performance of An Amorphous Silicon Grid-connected Photovoltaic System

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#### ABSTRACT

To analyze the performance and decrease the rate of PV array efficiency of the 4.872 kW a-Si grid -connected photovoltaic system (GCS), which is installed on the electrical engineering building in the faculty of Engineering and Architecture, Rajamangala University of Technology Suvarnabhumi Nonthaburi. An analysis method from the International Energy Agency Photovoltaic Power System Task2 (IEA PVPS Task2) was used. This system had operated since 2003 continuously to the present time. During the first three years analysis used electrical parameters from monthly recording from the electrical instrument that was built in the inverter of GCS, and used solar irradiance data from the Meteorological Department of Bangkok. Next two years analysis used all of parameters from the PC based recorder and real time monitor system that was developed by researchers. In the 5<sup>th</sup> year operation, GCS was developed so that it could check an operation system to increase the operation time of system (Final Yield: YF). During the five years of operation, this system generated 6133.7 kWh in average each year. The PV array efficiency in average is 6.03%, but is less than the average four years about 0.09%. The decreasing rate of PV array efficiency by the year is equal to 3.32%, and higher than the four years analysis is equal to 1.48%. The performance ratio (PR) in average is 0.74. It is higher than the average four years PR, because the GCS has a better checking operation system that was developed in the 5<sup>th</sup> year of operation. It was increased in the final yield of GCS.

SDEWES.2009.262

## **PV Plants European Market**

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### **ABSTRACT**

During last years in many European countries PV plants have been developed and installed, both for residential buildings as well for industrial and commercial buildings, even if many European countries, such Germany, northern Italy, etc. are not the best location where install a PV plant to produce energy.

This phenomena is mainly due to some factors:

1. awarding laws promoted by some local Governments;
2. use of the electric public grid as 'energy storage';
3. continue increase of crude oil price, and related energy prices;
4. continue increase of environmental consciousness of people;
5. energy performance increase of PV panels;
6. better PV plant design approach.

In this paper we'll deep analyze technical and formal conditions as shown above about PV plant installation for many European countries, and we'll analyze the PV plant installation in many European countries at the date of beginning 2009.

SDEWES.2009.299

## **Photovoltaics on Flat Roofs: Energetic Considerations**

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### **ABSTRACT**

Flat roofs present a large potential of suitable areas for installation of photovoltaic (PV) plants. Flat roof PV installations have the advantage of being able to be optimally positioned with support structures, and the inclination angle can be adjusted.

Due to the important technological development existing in the PV sector, there are different photovoltaic technologies in the market, whose energy and economic features substantially differ. It is of high interest to study the PV system production sensibility to the variation of the panel inclination, the space constraints and their consequences on the energetic and economic parameters.

This paper describes some useful parameters to choose the technology, distribution layout and tilt-angle of the modules to be installed in flat roofs and terraces on buildings. Depending on the specific requirement of the projects, the interest of the parameters is different. The parameters used in this study to evaluate the behaviour of the different PV configurations on buildings are:

- $\text{Wp/m}^2$  of surface: it determines the solution that allows to install the highest power in the building.
- $\text{kWh/kWp}$ : it determines the solution with highest specific production.
- $\text{kWh/m}^2$  of generation field: it determines the configuration that produces highest energy per  $\text{m}^2$  of generation surface.
- $\text{kWh/m}^2$  of available surface: it determines the configuration that produce the maximum of energy per  $\text{m}^2$  occupied with the PV installation.
- IRR: The internal return rate of the investment. It determines the financial risk assumed in the project. It is especially important for the projects where foreign financing is required and for those whose cash flows are negative during the first years.
- EROI: Energy return on investment, ratio of the energy delivered by the PV system to the energy used directly and indirectly in their fabrication, installation and use.

As case study, the possibilities of PV installation on the flat roofs of the Torres-Quevedo Building, located in the Campus of the University of Zaragoza, is presented. In order to perform a complete analysis, the different PV technologies available in the market are included.

SDEWES.2009.342

## **The Effect of PV Module Electric Properties on The Maximum Power Point (MPP) Trajectory with Aim of Its Alignment to Electrolyzer U-I Characteristic**

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### **ABSTRACT**

When we want to combine PV module and electrolyzer to produce hydrogen from water, it can be done using intermediate DC-DC converter which is needed to adapt module's output power features to the electrolyzer input power features. It can also be done without using electronics and than it is already calculated that the saving can be equal to 700 USD/kW. But than should be done a more sophisticated research work to preserve high system efficiency. The final result of that work appears as a concurrence of the PV module MPP trajectory (MPP path in U-I plane as a result of the solar irradiation change) and electrolyzer U-I characteristics.

This paper presents an analysis of the influences of PV module electric properties like series resistance, parallel resistance and ideality factor on the MPP trajectory at different solar irradiation. There is shown possibility of its different inclination (right-vertical-left) in respect of an arbitrary chosen electrolyzer U-I characteristic.

Simulated results are obtained using Matlab/Simulink simulations of the well known one diode model which are confirmed by experimentation with real PV module where solar irradiation, solar cells temperature, electric current and voltage in the circuit with the variable ohmic resistance have been measured.

SDEWES.2009.432

## **Solar PV Program in Fiji-is it a Resco Approach?**

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### **ABSTRACT**

Rural SHS electrification programs have been implemented in most countries in the Asia-Pacific region using a range of delivery mechanisms and financial mechanisms. Most of these programs, however, are not managing to keep pace with population increases. In Fiji the Program is implemented by the Department of Energy (DoEF) and has been developed to provide electricity for lighting for remote households located in rural areas where supplying electricity via the grid is not an economic option. A survey was carried out to measure the program success and to understand the issues related to program development. This research aims to provide a better understanding on the Fijian SHS program. The approaches used in implementation of the Fijian program are similar to those adopted in other countries of the region. The reported lack of success of the Fijian program therefore cannot be readily attributed to substantive differences from other programs in terms of the approach being used. Survey results shows that the impacts of the program on social issues are positive. The concept of RESCO did not support the Fiji program. The program relies on donor-supplied capital equipment to get started therefore not commercially replicable. All components under the program are owned by the Government and the tariff was designed only to cover the monitoring cost. It was found that the implementation of the program suffers from a lack of well developed support infrastructure. This manifests itself in weak monitoring and maintenance program that gives rise to significant technical problem. The program also suffers from lack of planning and policy. It is not a full RESCO program as the program is totally run by the Government and there is no service company who is responsible for the program. Government has not been generally successful in providing quality after sales support of the program. Overall, the program concept was good but it needs proper planning and implementation mechanism to make this program successful. There is a need to develop proper monitoring systems available under the program mechanism and ensuring quality service, quality components and implementation of the policy.

## Heat and Mass Transfer in Energy and Environment Systems I

SDEWES.2009.035

### Analysis of Recuperative Heat Exchanger Based on Heat Fluxes Exergy

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#### ABSTRACT

Recuperative heat exchangers are quite common part of air handling units. Mostly as one of many components within ventilation system it has to sub serve to main design. Therefore are often operated far away from optimal conditions ensuring high efficiency. Common analyses of recuperative heat exchanger efficiency usually focus on heat balance referring to the 1<sup>st</sup> thermodynamic law. Exergy analysis allows effective approach for evaluation of recuperative heat exchanger behavior in different operation states that respect also 2<sup>nd</sup> thermodynamic law. This approach is based on exergy definition of heat fluxes transferred between cooled and heated air. Exergy analysis allows including and comparing all heat fluxes on common basis respecting losses caused through irreversible heat transfer processes. As an exchanger's efficiency changes it is necessary to define particular parameters mostly influencing it. In this article is presented advanced approach to our previous method, now containing operation and heat transfer parameters. Transferred heat between air streams relay on operation parameters such as different air volume rates of cooled and heated air and temperatures of air streams at inlets. A heat exchanger itself has specific heat transfer parameters, constant one is an area of heat transfer surface. Uncertain parameter of the highest importance is heat transfer coefficient of a heat transfer surface. The most important member of exergy analysis is exergy of losing heat flux, describing heat losses between air flows. This parameter influences all partial exergy efficiencies and total also. The exergy efficiencies describe progress of heat recuperation according to the heat transfer coefficient and flow capacity of heated air stream. The results also reflect importance of equal air volume rates of cooled and heated air strongly influencing heat transfer effectivity. This is more obvious in the situation of high heat transfer coefficient.

SDEWES.2009.341

## **Entropy Generation Analysis in Film Condensation on An Elliptical Tube with Assisted Interfacial Shear Stress**

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### **ABSTRACT**

The importance of film condensation is due to its great number of industrial applications such as heat exchangers and condensers. Several condensing systems, such as flat plates, spheres, circular and non-circular cylinders have been extensively studied regarding the phase-change heat transfer problem of film-wise condensation. Based on the analysis performed by Semenov et al. if the contour of the cross-section of a non-circular horizontal tube on which condensation occurs is elongated in the gravitational direction that its curvature decreases continuously from the upper to the lower one, the condensation heat transfer is enhanced. Therefore, as elliptical tubes possess some advantages in heat transfer over cylindrical ones, they are of great importance.

An analytical study is made into the analysis of laminar film condensation on a horizontal elliptical tube by taking into account the shear force at the liquid vapour interface. As condensation occurs on the surface of the tube, a continuous liquid film runs downward over the tube under the simultaneous effects of surface tension causing a pressure gradient along the surface, gravity force and the vapor interfacial shear force considered to be constant over the whole interfacial length. A general relation is derived analytically for the liquid film thickness in the form of a nonlinear differential equation. Due to the complexity of this equation and based on the three forces applied at the liquid film, the problem is categorized into two limiting cases: condensation with the effect of surface tension and high gravitational force compared to the interfacial one and condensation with high shear force compared to the gravitational one. The effect of these forces on velocity and temperature profiles, heat transfer coefficient, and mass flow rate are discussed for various values of ellipticity ( $e$ ) for constant and variable wall temperature. Some of the results for special objects (vertical plate  $e=1$ , circular tube  $e=0$ ) are compared to the classical Nusselt-type solutions available in the literature.

It is shown that for both cases, the pressure gradient along the surface which is caused by the surface tension depends upon the radius of curvature gradient and has a positive value in the upper half of the tube and acts as an additional force to the two other forces. However, in the lower half of the tube, the pressure gradient is negative. Therefore, for the upper half of the tube the liquid film becomes thinner while for the lower half it becomes thicker resulting in higher and lower heat transfer coefficients for these two halves, respectively. Since the surface tension force has negative values at the lower half of the tube, it is also seen that a separation point exists where the liquid film thickness approaches infinity.

Finally, the relation for total entropy generation is derived for the two cases. Introducing two sets of dimensionless numbers, the existence of an optimum condition for each case is discussed by using an entropy generation minimization method (EGM).



SDEWES.2009.564

## **Thermal-fluid Assessment of Multijet Atomization for Spray Cooling Applications**

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### **ABSTRACT**

In electronic applications the miniaturization of electronic packaging is limited by the heat removal capacity of thermal management systems. This requires high performance cooling systems, capable of high heat flux removal to maintain low operating temperatures and have the ability of dynamically control the heat transfer process. Intermittent Spray Cooling (ISC) has been suggested as a promising technology for actively controlling the surface temperature. Recently, based on the ISC concept, a dynamic approach has been developed to improve empirical correlations for spray impingement heat transfer. But, ultimately, any spray cooling technology depends on the strategy used to atomize the cooling liquid, disperse its droplets as uniformly as possible and control the deposit of liquid onto the surface, avoiding excessive secondary atomization or pre-impingement-evaporation. Multijet spray technology has been suggested as an atomization strategy which has the potential of meeting this objective. A multijet spray is produced from the point of impact of multiple cylindrical jets, converting the impact momentum into hydrodynamic structures which further break into small droplets. These sprays have the advantage of being produced with relatively low flow rates and at relatively short distances (10 to 30 mm). The purpose of the work reported here is to assess such atomization strategy to perform spray cooling within the ISC concept. This is done by taking the multijet spray characteristics of atomizers with 2, 3 and 4 impinging jets, measured with a phase Doppler interferometer, at a certain measurement plane and use the correlations provided in, which consider an imposed heat flux, to estimate the heat removal if such spray impinged on a heated surface. Results explore the differences between the number of impinging jets and corresponding influence on the heat removal pattern, as well as in its order of magnitude. And conclude about the promising applicability of multijet sprays for innovating spray cooling systems, promoting the efficient use of energy in thermal management.

SDEWES.2009.428

## **Modelling for Design and Optimization of Vanadium Redox Batteries**

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### **ABSTRACT**

Modern demands for increasingly efficient energy delivery and the anticipated demand for renewable energy have generated considerable interest in redox-flow batteries (RFBs) as an energy storage technology. The potential applications of RFBs are numerous, including load leveling and peak shaving, uninterruptible power supplies, emergency backup and facilitation of wind and photovoltaic energy delivery. One of the most popular is the vanadium redox battery (VRB), which has the advantages that: it can offer almost unlimited capacity simply by using larger and larger electrolyte storage tanks; it can be left completely discharged for long periods with no ill effects; it can be recharged simply by replacing the electrolyte if no power source is available to charge it; and, if the electrolytes are accidentally mixed, the battery suffers no permanent damage.

In view of the rapidly approaching commercialization of RFBs such as the VRB, issues concerning the technology's poor energy-to-volume ratio and optimization with respect to operating conditions, cell geometry and cell materials will arise. An indispensable tool for handling these issues, in tandem with experiments, is modelling and simulation. However, unlike the case of conventional batteries or fuel cells where there already exist countless models in the literature, there are next to no models for the all-vanadium RFB; see for the only exception.

This paper combines ideas from earlier work in polymer electrolyte fuel cells and electrolytic pickling cells to derive a mathematical model for the operation of a power cell in a VRB. As with earlier work, in addition to describing the physics in detail, the simultaneous aim is a model that will not be computationally prohibitive when it is used to describe the operation of the stack of cells that are present in a VRB in actual applications.

SDEWES.2009.315

## **Design of a Centrifugal Blower Using CFD Methods**

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### **ABSTRACT**

The scroll is a critical component of centrifugal blower because it plays a dramatic role in efficiency and operating flow rates (region between surge and blockage). To assess the capability of a CFD code to study such a flow, a flow map of a centrifugal blower will be computed. In spite of its importance, there are very few detailed studies that deal with the scroll aerodynamics due to highly three-dimensional flow and its complex geometry, which makes the obtainment of a high quality mesh that is vital for a good aerodynamic analysis, a difficult task. In order to obtain the realistic data for scroll inlet, the impeller aerodynamics was investigated carefully. It is known that the wall functions cannot accurately predict the separation and reattachment regions. For this reason, the fine mesh of impeller has the averaged  $y^+$  nearly 1, to properly capture the separation flows near leading edge at off-design regimes. The maximum polytropic efficiency of blower is 0.84, that is remarkable if we take into account that the rotational speed of impeller is not optimal because the rotor is directly coupled to the electric (with no gearbox) to decrease the mechanical losses.

## Fundamentals Of Sustainability

SDEWES.2009.470

### **Sustainability Science: State of The Art and Future Perspectives**

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#### ABSTRACT

Over the last two decades sustainability science has benefited from the vibrant contribution of distinguished scholars, however a formal recognition of its epistemological value is very recent. The first International Conference on Sustainability Science (ICSS09) was held in Tokyo in February 2009 and leading universities and international research institutions were there in order to strengthen the foundation of this innovative and transdisciplinary science.

The aim of this paper is to not only review the cutting edge research core of sustainability science but also to describe the practical process behind its construction.

The first part of the paper reviews the main research trends of sustainability science and the methodological and epistemological issues that justify the transition from the traditional uni-disciplinary approach to the trans-disciplinary one. This section gives particular attention to the limitations of uni-disciplinary approaches in understanding and solving complex and interdependent phenomena, to the definition and conceptualization of sustainability and to its problem-solving capacity.

The second part describes the practical aspects of this developing field of science. We map out the agents involved at this stage, the way they interact and the ongoing collaboration with particular attention to the creation of the Network of Networks (NoN) of sustainability science. We describe the proposals set forth during the ICSS09 that will be presented at the next G8 Universities Summit and the main objectives of the ICSS10 that will be held in Rome in 2010.

SDEWES.2009.405

## **Application of Multi-criteria Analysis for The Evaluation of Sustainable Energy Systems - a Review of Recent Literature**

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### **ABSTRACT**

For sustainable development within energy supply energy systems have to be looked at from different disciplines as to incorporate all the consequences brought along with their implementation. As energy issues are usually complex, dynamic, dealing with uncertainty and different stakeholders there is a need for new decision tools. Multi-criteria decision analysis (MCDA including Multi-criteria decision making and Multi-criteria decision aid) has been applied manifold for decisions in energy management already. These decision tools are able to incorporate different perspectives of stakeholders, they account for quantitative as well as qualitative criteria and they separate objective and subjective aspects of a decision problem.

But how widespread are MCDA methods for energy decisions already? In this paper a review of the recent literature is published to analyse the potential of MCDA for real world applications. A classification is presented to indicate trends and challenges.

Since the 1960s many applications using MCDA-methods for energy issues have been published. Reviews done before cover the literature comprehensively until 2003. Our literature review focussed on articles published between 2004 and 2008. A trend of increasing energy applications for MCDA can be found. Also there is a strong focus on renewable energy systems. Especially the literature of the last two years shows that participation of stakeholders becomes more important. There are new approaches introduced such as Social Multi Criteria Evaluations and Participatory Multi-Criteria Analysis.

However, although there is extensive literature on MCDA for energy applications available most of the articles published are case studies accompanied by research institutes and public funding. Literature does not show whether MCDA-methods reached the energy supplying companies already. Moreover, there is a lack of ex post-evaluation giving an idea whether the MCDA-process was successful and indicating what could be learned for further applications.

In order to learn about the status quo of applications in energy supplying companies interviews are planned. Further a case study with stakeholders in a small town -especially local industry and politics- is under preparation.

SDEWES.2009.678

## **Sustainometrics and Information Theory**

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### **ABSTRACT**

Sustainometrics, as a new area of research, aims at providing integrated models and metrics for the description of the co-evolving relationships between the economy, society and nature. Its aim is to build on global information and global models and allow for these to be accessible locally for any processes of decision-making. The global nature of the sustainability agenda, including climate change priorities, is such that sustainometrics will have to meet the need of modelling the global system of the Earth and quantitatively measure the processes that are currently covered by other 'metric' sciences, such as econometrics, biometrics and sociometrics. Information theory can provide the basis for this to happen and allow the modelling of information processes occurring during the interactions of intelligent systems.

The nature of mathematical, information and computer modelling implies the use of formal descriptions. They are analogous abstractions of the reality as distinct to physical or social models based on the nature of things, e.g. objects that are worthy of being imitated. Information models that use information processes based on some formalisation of real-world behaviour require good understanding and clear definition of the objects that act as agents for these information processes. In other words, models that are created for an ill- or poorly defined area of inquiry, such as what is still the case with sustainable development, are unlikely not only to be trusted but also to be able to generate new knowledge. Their outcomes are not single-valued and can potentially be misleading.

Moreover the methodological problems of the current information theory paradigms, namely cybernetic, epistemological and pragmatic, are being challenged by the requirements of sustainometrics. Hence there is a need for a new approach to modelling based on information theory taking into account the following assumptions about the nature of information processes:

Information processes are real processes of system interactions;

Information processes are spontaneous and occur in an environment shaped by the interactions between the system's components;

Information processes are subject to the law of information relevance, which is based on the system's hierarchy, nature and complexity.

The paper concludes with the argument that the new information modelling for sustainability needs to include intelligence as an information category.

SDEWES.2009.406

## **Influence of Electricity Generation on Depletion of Exergy of Non-renewable Resources**

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### **ABSTRACT**

Power industry and other industrial processes have disadvantageous influence upon the natural environment. These disadvantageous influence results from depletion of non-renewable natural resources and from rejection of harmful substances to natural environment. The second influence leads to losses in such a fields as: human health, useful industrial or other manufactured products (corrosion of machines, buildings, transportation equipment etc.), agricultural and forestry production. We should compensate or prevent these environmental losses for example by application of cleaning-up installations. However, compensation or prevention of environmental losses leads to additional consumption of materials and energy and as final effect to depletion of natural resources. If we accept the exergy as a common measure of natural non-renewable resources quality the thermoeological cost can be defined as cumulative exergy consumption of non-renewable resources appearing in all the links of processes leading to final product with taken into account whole life time of the product. The paper presents brief description of the thermoeological cost analysis. The method of thermoeological cost of production of electricity are developed and described in details. Results of example calculations of thermoeological cost of electricity are presented and discussed. The possibilities of decreasing of the thermoeological cost are examind. Moreover the possible savings of domestic natural resources thanks to decreasing of such a cost are evaluated.

SDEWES.2009.140

## **The Detection and Assessment of Impending Regime Shifts from Fisher Information**

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### **ABSTRACT**

Resilient systems typically exhibit periodic fluctuations yet are able to withstand perturbations while maintaining function. However, it is possible for a system to reach a dynamic threshold and shift to another set of system conditions. Regime shifts have been demonstrated for a multitude of ecological and social systems, and often have significant ecological and economic consequences. While much research has been focused on detecting regime shifts, from an adaptive management perspective, it is key that regime shifts be identified before they occur. Rising variance, kurtosis, skewness, and critical slowing down have all been proposed as indicators for impending regime shifts in complex adaptive systems. We propose the use of Fisher information as a method of detecting impending regime shifts. In this study, the detection approach is demonstrated through the assessment of model and real systems. We believe this research has tremendous implications for socio-ecological resilience, and therefore, sustainability.



## Towards Sustainable Combustion I

SDEWES.2009.085

### **Worldwide Trends in The Development of Fbc Technology: its Contribution to a Sustainable Energy Supply**

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#### ABSTRACT

Fluidized bed combustors have excellent mixing characteristics of the solids, high heat transfer rates and burn efficient with low emissions. This statement is proved by a very wide range of worldwide experiences of the FBC technology since the 1970s, the start of operation of the first industrial-scale BFB boiler. A number of other advantages have been becoming well-known since that time, such as a perfect acceptability of problematic fuels of e.g. low calorific value, high ash and moisture or high sulfur, and also the flexibility against timely changes in fuel quality. Similarly, the limitations of the fluidized bed technology became known as well.

The demand on thermal utilization of a range of such 'problematic' fuels such as biomass and waste increased nowadays the need of collecting and systematic exchanging of knowledge accumulated during the past three decades in the area of operating practice and knowledge of FBCs. A new network has been set up for this reason under the support of the Austrian ministry BMVIT and International Energy Agency (IEA), where besides basic technical experience also open and solved problems are exchanged in a quantified manner.

State of the art is already the utilization of a fuel mix (mainly wood wastes, bark, sludges, coal) in relatively small (< 50 MW) and large fluidized bed combustors. Future developments are an increased utilization of sewage sludge, small fluidized bed combustors (< 50 MW) with wood as the main fuel and large units (> 100 MW), as well as the utilization of municipal solid waste and gasification.

SDEWES.2009.063

## Conversion of Brown Coal At Continuous Supply of Coal-water Slurry into Reactor on Supercritical Water

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### ABSTRACT

The main problem for implementation of existing technologies of low-grade fuels processing in coal fuel industry, petrochemistry and power engineering is low efficiency caused by the following factors: high content of mineral components and oxygen; non-homogeneity of fuel by its chemical composition and physical properties; high costs of transportation and preparation of fuel (demineralization, grinding, and moisture removal); support of environmental safety. It follows from comparison of published data on fuel conversion in supercritical organic solvents and supercritical water (SCW) that water at the supercritical state provides the highest performance of the process. Taking this into account and considering the fact that water is the environmentally clean and cheapest solvent the interest to application of SCW as the medium for conversion of low-grade fuels increased recently.

In this report the results of conversion of coal organic matter (COM) in supercritical water at continuous supply of coal-water slurry (CWS) into the flow reactor under the pressure of 30 MPa and temperature of 390–760°C will be discussed. It was found that when coal particle of CWS falls into reactor depending on the SCW temperature about 44–63% of COM is ejected from the particle as liquid and gaseous products. We have termed this stage of SCW conversion as dynamic conversion (DC) of coal. It turned out that particles which passed the DC stage do not aggregate in the reactor during the following process of static conversion (SC) within a coal layer. The specific surface of coal residue after DC is increased with rise in temperature from 8.8 (400°C) up to 268.4 (665°C) m<sup>2</sup>/g. The volatile products of the total process of coal DC and SC include paraffin (CH<sub>4</sub>, C<sub>2</sub>H<sub>6</sub>) and aromatic hydrocarbons (C<sub>6</sub>H<sub>6</sub>, C<sub>7</sub>H<sub>8</sub>, C<sub>8</sub>H<sub>10</sub>) together with syngas (H<sub>2</sub>, CO) and CO<sub>2</sub>. Researches of shared dynamic and static conversion of coal in SCW/O<sub>2</sub> fluid at P=30 MPa and change of temperature 550-760°C have shown that increase of H<sub>2</sub> yield is caused by decomposition of water at interaction with carbon of coal, and increase of CO<sub>2</sub> yield is also due to oxidation of coal residue by oxygen. The investigation of ash have shown carbon absence and high porosity of ash microparticles.

In general, due to our investigations on coal conversion and combustion in SCW, we have developed an absolutely new power-saving environment friendly scheme of coal conversion into different liquid and gaseous products, including H<sub>2</sub>. The power-saving effect is obtained due to coal combustion directly in water (heat carrier and actuating fluid of power-generating devices). Simultaneously, the auto-thermal character of conversion is provided by initial low-grade fuel. The maximal working temperature of the process

(750°C) is reached inside the reactor (in the heat-carrier), and the outer walls have a lower temperature and they are not oxidized. All heat energy of the process can be potentially used, in particular, for electricity production. Universality of this scheme for any kind and grade of fuel is also an important power-saving component, which excludes additional expenses on preliminary treatment of fuel.

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SDEWES.2009.546

## **Influence of Reaction Parameters on Synthesis of Fame from Rapeseed Oil**

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### **ABSTRACT**

Increasing biodiesel use requires optimized production processes allowing high production capacities with low energy consumption, simplified operations, high yields and purity, and the absence of waste streams. The most common process for production of FAME is transesterification reaction. During this process the vegetable oil reacted with methanol in presence of alkali as a homogeneous catalyst and yield FAME as product and glycerol as by product. The production yield and purity of biodiesel depends from purity of reagents, mixing time, reaction temperature, type and concentration of catalyst and molar ratio of methanol to oil. Only high quality rapeseed oil allows the successful production with low level catalyst concentration, what simplified the removal the catalyst after the end of reaction and reduce the amount of wastewater produced to clean the product. In conventional homogeneous method the synthesis of biodiesel usually is realized at molar ratio of methanol to oil 3-6:1 through convectional heating of the mixture of reagents and catalyst in the temperature range 40 - 60°C. After the end of the reaction the reaction mixture is cooled to the room temperature and formation of two layers occur. Because the procedure of washing and cleaning depends on concentration of the methyl ester in the biodiesel phase it is very important to have high purity of this phase. In this paper we studied the effect of variation of molar ratio of methanol to oil, concentration of catalyst and reaction temperature. The obtained results shows that the increase of molar ratio of methanol to oil forces the reaction equilibrium toward the products, however above the molar ratio 4:1 the additionally effect is depleting. Increase the concentration of catalyst gives similar positive effect, but not over the optimum, in our case it was 0,75% m/m from oil. Below the 30°C the reaction occur slowly and only above 50°C occur rapidly enough.

SDEWES.2009.150

## **Selection of Sustainable Technologies for Combustion of Bosnian Coals**

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### **ABSTRACT**

Improving existing and introducing advanced coal combustion technologies, with a view to increasing efficiency and improving environmental performance, is a key challenge for coal power sector. Due to increase of the world energy consumption and rising problem of global warming and climate change, the attention is focused on sustainability of coal-based electricity generation. Sustainability assessment is recommended to be performed and offered to decision makers when new application in coal-based energy system is under consideration. Under such an assessment, the system is considered from economical, environmental, technological, social, political, ethical and some other aspects. The aim of that procedure is providing an environmental friendly, economically feasible and socially balanced coal-based system.

This paper deals with optimization of coal combustion conditions to support selection a sustainable combustion technology and an optimal furnace and boiler design. A methodology for optimization of coal combustion conditions is proposed and demonstrated on the example of Bosnian coals. The properties of Bosnian coals varies widely from one coal basin to the next and even between coalmines within the same basin, while very high percentage of ash (particularly in Bosnian brown coal) makes clear certain differences between Bosnian coal types and other world coal types, providing a strong argument for investigating specific problems related to the combustion of Bosnian coals, as well as ways to improve their combustion behaviour.

In this work, options of energy system (boiler) with different process temperatures, corresponding to the different combustion technologies; PF combustion (slag tap or dry bottom furnace) and fluidized bed combustion, are under consideration for the coals tested. Sustainability assessment, based on calculation economic and environment indicators, is used for the optimization in combination with common Low Cost Planning (LCP) method. The total costs in the lifetime are presented by General index of total costs, calculated on the base of agglomeration of basic economic indicators and the economic indicators derived from environmental indicators. So, proposed methodology is based on identification of those combustion technologies and combustion conditions for coals tested which the total costs in life time of the system under consideration are lowest, provided that all environmental issues of the energy system is fulfilled during the lifetime.

Inputs for calculation of the sustainability indicators are provided by the measurements on an experimental furnace with variation process temperature, supported by good praxis from the power plants which use the fuels tested and by thermal calculations of the energy system.

SDEWES.2009.441

## **Nanocrystallization of Mg<sub>6</sub>Ni in Mg - Rich Amorphous Alloys**

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### **ABSTRACT**

The amorphous Mg – Ni metallic glasses have intensively been studied due to their possible application as hydrogen storage materials. On the other hand, they can be used as precursors in the synthesis of new nanocrystalline phases with interesting physical and chemical properties. Devitrification and nanocrystallization of Mg rich metallic glasses leads to the formation of the metastable Mg<sub>6</sub>Ni phase. During continuous heating Mg<sub>6</sub>Ni phase transforms to the equilibrium  $\alpha$ Mg and Mg<sub>2</sub>Ni.

The present study aims understanding of the mechanism and kinetics of Mg<sub>6</sub>Ni formation in a metallic glass with composition Mg<sub>88</sub>Ni<sub>12</sub>. Thermal stability and crystallization kinetics are studied by means of DSC under pure argon atmosphere. The DSC curves show that the crystallization is a two step process.  $\alpha$ Mg phase crystallizes first at 433 K and then Mg<sub>6</sub>Ni phase at 478 K. Isothermal calorimetric curves in the temperature range 438 – 448 K are obtained. JMKA equation is found to describe adequately the nanocrystallization kinetics studied and Avrami exponent of  $n = 3$  is obtained, showing three-dimensional linear growth mechanism. The activation energy of the process is found to be  $Q = 584 \pm 83$  kJ/mol. DSC study at different heating rates (2.5 – 40 K/min) allowed determination of the effective activation energy for the two crystallization reactions by the Kissinger method. The activation energies obtained are  $188 \pm 8$  kJ/mol for the Mg phase crystallization and  $197 \pm 84$  kJ/mol.

## Advances in Waste Management II

SDEWES.2009.184

### **Waste Management Activities and GHG Emission Control in Croatia**

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#### **ABSTRACT**

Climate change policy is one of the key factors in the achievement of sustainable development in the Republic of Croatia. Control and mitigation of greenhouse gases (GHG) is correlated with all economy activity. Waste management is one of the main tasks of the environmental protection in the Republic of Croatia. Waste Management Strategy of the Republic of Croatia (OG 130/05) and Waste Management Plan in the Republic of Croatia (OG 85/07) define the concept of waste management hierarchy and direct and indirect measures as criterion for sustainable waste management establishment. The main constituent of this system is waste avoiding and minimization, as well as increasing of recycling and recovery level of waste and landfill gas, which also represent GHG mitigation measures.

Contribution of the methane emission from landfills amounts about 1-2% of the total GHG emission in Croatia. Climate change control and mitigation measures as an integral part of waste management sectoral strategies represent measures for achievement of national objectives towards GHG emission reduction, which Croatia has accepted in the framework of Kyoto Protocol.



SDEWES.2009.369

## **Waste Management in Rural Areas in Styria/Austria - Potentials of Optimization Under the Aspect of Demographic Changes and Depopulation**

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### **ABSTRACT**

The suggested paper deals with 'Waste management in rural areas in Styria/Austria - potentials of optimization under the aspect of demographic changes and depopulation'. In many rural regions in Austria there is a need of the adaption of waste management structures in such areas. They are strongly affected by a negative demographic change in the sense of an aging of rural population together with a thinning process in many municipalities. Beside this social aspect also the economic aspect becomes more and more important. A decreasing number of populations together with lower incomes for the municipalities on the one hand and the high requirements to the infrastructure (e.g. waste collection systems) which became more expensive during the years cry for innovative solutions. These could be a new kind of cooperation between municipalities on the one side and tailor made offers for the costumers. At the example of selected municipalities in Styria both cooperation models on the basis of Private-Public-Partnerships and re-municipalisation will be shown and discussed and methods of generating optimization data will be introduced in this paper. The focus lies on collection centers for potential recyclable waste material. Nowadays these centers are of increasing interest for waste collection companies and municipalities because well separated recyclable waste materials allow additional incomes. Of course all mentioned aspects will be lighted under the actual economic situation and expected development.

SDEWES.2009.419

## **Analysis of Sustainable System for Energy Recovery from Municipal Waste in Croatia**

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### **ABSTRACT**

Efficient waste management is one of preconditions for sustainable development of each country. In spite of increasing share of waste which is separately collected for the purpose of recycling and recovering, the quantity of waste that finishes at the landfills is growing each year. Therefore, the EU has recently prescribed that the waste which has not been previously treated will not be allowed to be disposed to landfills. The principles of sustainable development state that such treatment should also include material and energy recovery.

The paper focuses on the segment of energy recovery from municipal solid waste in Croatia. The state strategy is based on the mechanical and biological treatment of waste in the future waste management centers. Left over after the treatment is waste that can be used as fuel (e.g. refuse derived fuel, RDF). RDF can be used as a substitute fuel in cement kilns and thermal power plants as well as in dedicated waste-to-energy plants.

Starting from the geographical distribution of the waste generation (quantities and transport distances), taking into account the costs of collection, transfer and thermal treatment, recommendations on optimal number and size of the plants as well as the choice of the possible locations for the future waste-to-energy plants in Croatia are given.

Second part of the paper examines opportunity of the cement industry in Croatia to utilize ash from thermal treatment of waste in the process of the cement production and the RDF as a substitute fuel.

SDEWES.2009.476

## **Waste to Energy by Industrially Integrated Scwg -effects of Alkali Salts in Real Biomass Streams**

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### **ABSTRACT**

Supercritical water gasification is a method, with which biomass can be converted into a hydrogen-rich product gas. Industrial waste streams, containing both organic and inorganic material, are well suited for treatment by SCWG. The results are however highly dependent on the type of material that is gasified and the types of inorganic material that are present. Two streams of biomass resulting from the pulp and paper industry have been studied to investigate the outcome of supercritical water gasification of these specific feeds. The purpose of the process is to convert these to useful products, both gaseous and solids, which can be used internally in the process or in external applications.

The gasified streams were paper sludge from the papermaking process and black liquor from the pulping process. The experiments were performed in laboratory scale, in an experimental reactor system, which has been constructed for the purpose of investigating the suitability of supercritical water gasification of various industrial waste streams. The differences in the composition of the material showed large effects on the gasification results. Especially the high alkali content in black liquor proved to be important for achieving high gas yields, rich in hydrogen and without carbon monoxide. The slippery character of alkali also made the feed easily handled at high dry matter contents. Experiments with alkali salt addition to paper sludge showed similar results as black liquor, thus confirming the high influence of alkali on gasification. Mixing paper sludge with black liquor produced similar results as when pure alkali salts were mixed with paper sludge, thus making it possible to raise the dry matter content and gasification yield without expensive additives.

SDEWES.2009.171

## **Utility Services in The Light of Transition Changes**

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### **ABSTRACT**

The paper analyses social, technical, spatial and commercial contexts of utility provision and use that are changing. The new pressures for change, besides privatization and liberalization of utility service markets also include the tightening of environmental standards, new forms of economic incentives, the high cost of network modernization, competition between a growing number of viable technologies, uncertainty over future consumption patterns and overcapacity in some networks. Particular attention is focused on the area of water supply, wastewater and solid waste management services. The author proposes possible solutions for controlling the quality of services from the part of public authorities.

## Solar Thermal Heat and Power I

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SDEWES.2009.167

### **Exergetic Comparison of Two Different Cooling Technologies for The Power Cycle of a Solar Thermal Plant**

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#### **ABSTRACT**

Exergetic analysis is without any doubt a powerful tool for developing, evaluating and improving an energy conversion system. In the present paper, two different cooling technologies for the power cycle of a 50 MWe Solar Thermal Plant are compared from the exergetic view point.

The Ranking cycle design is a conventional, single reheat design with 5 closed and 1 open extraction feedwater heaters. The software package Gate Cycle is used for the thermodynamic simulation of the Rankine cycle model. The first design configuration uses a cooling tower while the second configuration uses an air cooled condenser.

With this exergy analysis we identify the location, magnitude and the sources or thermodynamic inefficiencies in this thermal system. This information is very useful for improving the overall efficiency of the system and for comparing the performance of both technologies.

SDEWES.2009.415

## **Study of Performance Characteristics of a Solar Thermal Water Pump**

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### **ABSTRACT**

Solar energy, a clean form of energy, is falling on earth's surface in plenty. Solar thermal water pump is working by utilizing the pressure difference during the condensation and evaporation of working substance employing solar energy as input. In the present work, a water pump is designed and fabricated with di-ethyl ether as working medium. This experimental pump is capable of lifting water more than 5m. The performance of the pump is studied, and even if the efficiency is very low, the device developed is suitable for agricultural and domestic level operation, as it is simple, compact, automatic and uses the energy available at free of cost.

SDEWES.2009.289

## **Simulation of a Stand-alone Solar Thermal Electric Power System with Integrated Long-term Energy Storage**

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### **ABSTRACT**

This study aims to develop of a solar thermal electric power system operating continuously 24 hours daily during a year. The electric power generation is supposed to cover load demands by using solar concentrated power (CSP) as the dominant, approaching 100%, energy source, despite of the intermittent nature of solar irradiation. CPS has been already proven as the most efficient and cost-effective form of solar power for industrial scale utilities in areas with more than 2 MWh/m<sup>2</sup> of annual direct normal irradiation. The major CSP technologies are the parabolic trough, linear Fresnel trough and power tower, which can be applied for electricity production via the conventional Ranking steam cycle. The overall power system design development is focused on the long-term solar energy storage as an ecologically safe alternative to the state-of-the-art hybrid solar-fossil fuel power cycles, for which the solar share is below 30% of the total load during a year.

The considered general scheme of a stand-alone solar electric power plant consists of four major components: a solar collector (e.g. parabolic troughs), a thermal energy storage unit, a power block (e.g. electrical generators), and an energy management system. In order to quantify the energy storage capacity demanded for a yearlong storage system, statistical analyses were performed based upon the available databases of solar radiation flux measurements and the location-time related urban area electric load profiles.

The results of simulations reveal the storage capacity variability on a one-hour timescale during a year of continuous operation. The nominal storage capacity value can reach approximately 5-10% of the total annual energy consumption, depending on the load profile. The performance of a long-term energy storage is characterized from the standpoints of basic thermal cycles (charge, discharge, both merged) and typical operational modes (stable and transient conditions of power input/output, peaking load response).

Conclusions are drawn about feasibility of the existent thermal storage technologies to match the long-term process requirements for stand alone solar power applications.

SDEWES.2009.650

## **Solar Hot Water Self-production on Venezuelan Andes**

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### **ABSTRACT**

'Hot water from the Sun' is a project on solar energy that was successfully completed together with some Andes communities in December 2008 in the municipality of Rangel, in the Federate State of Merida Venezuela. A development project can't leave aside technology and its overall applications, but at the same time, it can't replace human reason, history and traditions with advancement. 'Hot water from the sun' is a project on self-construction of solar panels made up of local and low cost materials in the rural communities of the Venezuelan Paramo (a poor and isolated area in the Andes Mountains). A theoretical training on technology and practical workshops on self-construction were held in the target families belonging to the communities. In these meetings, it was built a solar collector with an hydraulic circuit that was used in the target families' houses.

Solar thermal technology has been successfully used in different contexts and it has proved to be useful also in developing countries, such as Venezuela. There, daily solar radiation reaches 5 kWh during the whole year, guaranteeing thermal energy supply to heat sanitary water. The project is valuable because it develops energy directly from bottom: the communities that need it most.

In order to realize the project, we first adopted a 'basic needs approach'. Caribana association, that has been working in the area since a long time, collected the real needs of local populations. In the whole framework, 'appropriate technology' means the application of technical tools that are useful and accepted by those who received them.

The distinguishing features of the area is its geographical position, and especially its height. Every communities is placed on Andean Mountains' steep slopes (Mucuchies, the main city is 3000 m over the sea level) and even if it is an equatorial area, the temperatures are cold. It was found that the main problem is related to sanitation problems: arthritis and rheumatism, because of cold water's usage for houses cleaning and clothes washing (water at 5°C) and children affected by infective diseases because of insufficient personal hygiene.



SDEWES.2009.485

## **Monitoring and Dynamic Simulation of An Existing Solar Powered Absorption Cooling System in Zaragoza (spain)**

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### **ABSTRACT**

Since two years ago the performance of a solar powered absorption cooling installation has been analyzed. The installation supplies the cooling demand of a gymnasium placed in the University of Zaragoza. The solar cooling system consists mainly of 37.5 m<sup>2</sup> of flat plate collector, a 4.5 kW, single effect, BrLi-H<sub>2</sub>O rotary absorption chiller and a dry cooler tower to cool the absorption cycle. Additionally, the system includes a 700 liter hot water storage tank, to solve the temporal mismatch between the gymnasium cooling demand and the solar offer, two fan coils are used for the distribution of the cooling energy and the driving heat for the chiller is provided by two gas boiler when the solar heat is not enough. To carry out the installation analyses, the system was consequently monitored.

The performance analyses of the solar driven chiller have shown average values of COP close to 0.6 in 2007 and between 0.46 and 0.56 in 2008. Concerning to the average cooling power, the chiller reaches values between 4.0 y 5.6 kW in 2007 and between 3.6 and 5.3 kW in 2008.

During the analyses phase, a detailed model of the solar cooling system was developed using the simulation environment TRNSYS. Monitored climatic data of the installation location has been used to develop the model. Furthermore, a detailed model of the rotary absorption chiller was implemented to be included in the whole installation model. The dynamic simulation model was validated and compared with the measured data. The simulation results show a good agreement with the measurements. Thus the model will be used for the evaluation of further investigations and improvements in the installation.

The measured data as well as the simulation results of the installation show the strong influence of the cooling water temperature and the generator driving temperature on the COP. The simulation results also show the improvement capacity of the installation performance with others control strategies.

After the experimental and simulation evidence of the influence of the cooling water temperature, a geothermal cooling system has been studied and executed. The installation

with the new variation starts to work the present 2009 year. With the geothermal cooling system it is expected that the COP of the chiller will be improved up to 42% more than the current one.

## Heat and Mass Transfer in Energy and Environment Systems II

SDEWES.2009.178

### **Pollutant Transport Models in Porous Media**

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#### **ABSTRACT**

In this paper pollutant transport in porous media models are presented. The purpose is to identify in this way different water purification technologies and identify those which are sustainable or suggest new water purification technologies.

SDEWES.2009.179

## **Heat and Mass Transfer Models in Semiconductor Crystal Growth Technology**

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### **ABSTRACT**

In this paper different heat and mass transfer models, appearing in semiconductor crystal growth technology are presented. The purpose is to compare in this manner technologies and identify those which are sustainable, eventually suggest new technologies

SDEWES.2009.340

## **Analytical Modelling of The Transport Phenomena on Temperature and Moisture History of Food During Drying Process**

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### **ABSTRACT**

Forced convection by hot and dry air is the most widespread industrial technique to execute food drying. In the literature, over 200 drying models have been offered for various foods, which are formally characterized by two different physical and empirical approaches. Food science is experiencing a transition from empirically based approach for quantifying the dehydration of dry food particulates to physically based models that are mainly derived by some assumptions. As a general rule, there has been a need for more experimental validation and for establishing the usefulness of the approximate methods for fully modelling drying process.

The complete description and accurate prediction of the drying have not still been possible. The mathematical formulation of heat and mass transfer in drying process is often based on nonlinear unsteady equations. In general, numerical simulations are required to solve these equations. Numerical modelling of food has been conducted in the past. In some simple case, an analytical solution can be obtained for mass transfer equation. Very often, in analytical procedure, indirect and simplified methods neglecting fundamentals of the processes are used. The most common simplification is that the food temperature is constant and the heat transfer is neglected. This assumption lets solve the mass transfer equation analytically but decreases the ability to reproduce experimental drying data.

This research presents a new mathematical model for both heat and mass transfer occurring during drying of sliced foods. The main connotation of this study regards the possibility of using analytical solution for simultaneous heat and mass transfer. The model considers fundamentals of the drying process and takes internal resistance to temperature and moisture into account. This model regards the evaporative heat transfer at the surface of product which is interesting for our study. Considering analytical solution, the focal innovation introduced in this study is represented with the model formulation. In this procedure the same concept of solution is applied for both heat and mass transfer equations. The verification of the model is made with numerical solution, which is implemented by the authors, and a set of experimental results reported in the literature for carrot sliced in slab form. The results reveal that there is nearly perfect match between the temperature and moisture obtained by the analytical model and experiments. Numerical and analytical results have shown remarkable agreement and the predictions overlap and relative errors never exceed 3%.

SDEWES.2009.539

## **The Determination of Thermodynamic and Transport Properties for Modern Refrigerants**

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### **ABSTRACT**

In the engineering practice refrigeration processes occurring in liquid-gas region are of vital importance. In order to design devices of this field of activity, it is necessary to know the thermodynamic properties of state in a one and two phase environment for pure refrigerants and their mixtures.

In most cases the thermodynamic tables or diagrams or different empirical functions obtained from measurement are used (classical thermodynamics). These equations are more complicated but they have no insight into the microstructure of matter and poor agreement with experimental data outside interpolation limits. Statistical thermodynamics on the other hand, calculates the properties of the state on the basis of molecular motions in a space and intramolecular interaction. The calculation of the thermodynamic functions of state is possible by many statistical theories. One of the most successfully is the perturbation theory. Several equations of state have been published that are based on perturbation theory. In this paper we compared new Tang-Tong-Lu (TTL) model, Chunxi-Yigui-Jiufang (CYJ) model, Johnson-Zollweg-Gubins (JZG) semi-empirical model, and Mecke et al. (MMWF) model. All these models are based on Lennard-Jones intermolecular potential function. The Lennard-Jones intermolecular potential is an important model for studying of simple fluids in one and two-phase region. It is widely used as a reference potential in perturbation theories for more complex potentials.

The paper features the mathematical model of computing equilibrium and nonequilibrium thermophysical properties of state in the liquid and gas domain for pure refrigerants and mixtures with the help of classical thermodynamics and statistical thermodynamics. The paper features all important contributions (translation, rotation, internal rotation, vibration, intermolecular potential energy and influence of electron and nuclei excitation). To calculate the thermodynamic properties of real fluid the models on the base of Lennard-Jones intermolecular potential were applied. To calculate the thermodynamic properties of real fluid with help of classical thermodynamics we used Tillner-Roth-Watanabe-Wagner (TRWW) equation on the base of Helmholtz type. We developed the mathematical model for the calculation of all equilibrium and nonequilibrium thermodynamic functions of state for pure refrigerants. The analytical results obtained by statistical thermodynamics are compared with the TRWW model and show relatively good agreement.

## Approaches to Sustainable Development: Methodologies I

SDEWES.2009.103

### Comparison and Analysis of Three World Energy Models

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#### ABSTRACT

This paper compares the assumptions and the results of three world energy models until year 2030. The aim is to find out the differences between the models, to detect the reasons behind the different forecasts or the perceptions and to examine to what extent they influence society. Since the forecasts and energy scenarios may vary from one region to another, beforehand there is no 'right scenario'. The analysis of the results and developments that are described in the long-term scenarios and their impacts in the short-term planning constitute the core of this study.

SDEWES.2009.196

## **Energy Wedges: a Systematic Way of Addressing Energy Security and Climate Change**

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### **ABSTRACT**

Stabilization wedges were first proposed by Pacala and Socolow as a means of addressing climate change (Pacala & Socolow, 2004). They illustrate the potential policy benefits of restricting all new energy supply and services to low- or non-carbon energy sources, thereby effectively stabilizing existing greenhouse gas emissions at a known level. This paper extends the stabilization wedge concept into three distinct energy wedges that can be applied to energy security.

A methodology, known as the four 'R's of energy security, has been developed to examine and propose improvements to a jurisdiction's energy security (Hughes, 2009). The wedges employ three of the 'R's: reduce (use less energy), replace (shift to secure sources), and restrict (limit new demand to secure sources). The fourth 'R', review (understanding the problem), allows the identification of a jurisdiction's energy supplies and services.

All energy wedges have a horizontal axis (time) and a vertical axis (demand). The effect on demand depends upon the type of wedge being applied. A reduction wedge represents actions that reduce demand for a given energy service. Replacement wedges are employed when an existing insecure or environmentally destructive energy source is replaced by one that is secure. A restriction wedge is for new demand and limits the supply to secure sources. All three wedges illustrate the annual interim steps required of a jurisdiction to meet some long-term target.

The three energy wedges can also be applied to environmentally-related energy issues such as climate change. Ideally, the energy sources used for replacement and restriction wedges should be both secure and environmentally benign; however, as history has shown, when security of supply is lost, political expediency can lead to the development of wedges that favour security over the environment.

This paper introduces the four 'R's of energy security and shows how they work with energy wedges. Applications of energy wedges in different jurisdictions are presented by considering various energy services and their energy supplies. The paper also demonstrates the versatility of energy wedges: as an educational tool, as a policy instrument, and as an energy scenario builder.



SDEWES.2009.012

## **Competing Dimensions of Energy Security: an International Perspective**

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### **ABSTRACT**

How well are industrialized nations doing in terms of their energy security? Without a standardized set of metrics, it is difficult to determine the extent that countries are properly responding to the emerging energy security challenges related to climate change, growing dependence on fossil fuels, population growth and economic development. In response, we propose the creation of an Energy Security Index to inform policymakers, investors and analysts about the status of energy conditions. Using the United States and 21 other member countries of the Organization for Economic Cooperation and Development (OECD) as an example, and looking at energy security from 1970 to 2007, our index shows that only four countries—Belgium, Denmark, Japan, and the United Kingdom—have made progress on multiple dimensions of the energy security problem. The remaining 18 have either made no improvement or are less secure. To make this argument, the first section of the article surveys the scholarly literature on energy security from 2003 to 2008 and argues that an index should address accessibility, affordability, efficiency, and environmental stewardship. Because each of these four components is multidimensional, the second section discusses ten metrics that comprise an Energy Security Index: oil import dependence, percentage of alternative transport fuels, on-road fuel economy for passenger vehicles, energy intensity, natural gas import dependence, electricity prices, gasoline prices, sulfur dioxide emissions, and carbon dioxide emissions. The third section analyzes the relative performance of four countries: Denmark (the top performer), Japan (which performed well), the United States (which performed poorly), and Spain (the worst performer). The article concludes by offering implications for policy. Conflicts between energy security criteria mean that advancement along any one dimension can undermine progress on another dimension. By focusing on a 10-point index, public policy can better illuminate such tradeoffs and can identify compensating policies.

SDEWES.2009.049

## **Developing an Integrated Sustainability Assessment Tool for Urban Environments**

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### **ABSTRACT**

This paper describes the preliminary results of a four year EPSRC funded research project whose aim is to produce an integrated sustainability assessment toolkit (ISAT) providing a comprehensive and transparent framework that encourages key decision-makers to systematically assess the sustainability of urban developments taking account of scale, life cycle, location, context and all stakeholder values. Its principal purpose is to allow the user to determine in an integrated and holistic way the relative sustainability of alternative designs taking account of the economic, environmental and social dimensions of sustainability. The tool has a knowledge capture system embedded in it. It has been designed for use predominantly on green or brown field sites, at all stages of a project's lifecycle and consists of 5 modules.

1. Module 1 is an input module defining the context and parameters of a scheme
2. Module 2 identifies sustainability impacts and their relative weights
3. Module 3 identifies the tool or tools whose output(s) are most likely to satisfy the user's requirements. The tools operate outside the ISAT environment and the results are imported into
4. Module 4, which integrates their output using a multi-criteria decision-making approach.
5. Module 5 is a reporting module allowing the outputs to be expressed in a variety of ways.

The ISAT is delivered as a web application with an integrated help and comment system, built in Ruby using the Rails framework, with all data stored in a MySQL database so that anyone with a web browser can use it.

The paper will describe the tool, and highlight the challenges that faced its development. In particular, it will explain how we:

- produced a map of the sustainability assessment process for urban developments based largely on the RIBA Plan of Work
- identified and mapped the interrelationships between some 1600 sustainability issues and some 900 indicators of sustainability, and how this very complex landscape was reduced to about 20 key impacts
- selected some 30 assessment tools for the ISAT to access from the 700 or so that we identified,
- set about integrating their outputs.

SDEWES.2009.407

## **Identification of Neural and Regression Models of Thermal Processes**

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### **ABSTRACT**

Identification consists of the development of models mapping the relations between inputs and outputs of the analyzed process. Such models are built basing on so called identification experiment. The identification experiments can be based on results of industrial measurements or special measurements as well as can be based on simulative model of the process. Regression or neural empirical models obtained by means of the identification process are rather simple and are characterized by relatively short computational time. For this reason they can be effectively applied for simulation and optimization of steering and regulation processes as well as for control and thermal diagnosis of operation (eq. power plants or CHP plants). In the paper regression and neural models of thermal processes developed for systems of operation control of thermal plants are presented. For the identification of developed models results of industrial measurements, special measurements and results obtained by means of simulative models have been applied. Theoretical-empirical models of processes proceeding in power plants and CHP plants have been worked out. Simulative calculations basing on these models have been carried out. Results of simulative calculations have been utilized for estimation of coefficient of parametric models and for determination of structure and weights of neural models. Example results of identification of developed models have been presented and discussed.

SDEWES.2009.551

## **Application of Life Cycle Assessment for The Biodiesel Production from Palm Oil Using the Methodology "From Cradle to Cradle"**

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### **ABSTRACT**

Natural systems were perceived for a long time as sources and sinks of unlimited resources. With population growth and the consequent growth of the exploitation systems the shortage of resources began and there were begun to perceive the damage caused to ecosystems by the activities that were being developed for decades. From those resources the one that most worries the international community is the petroleum, for this reason it is proposed the use of biofuels like the biodiesel. Colombia through governmental maneuvers has proposed to become world-wide power in biofuels, but in the middle of this marathonic race it has not done the pertinent studies for such aim. This document contains a study realized for the area of Puerto Wilches (Santander), palm zone for decades and is projected as biodiesel-producer area in Colombia.

The Life Cycle Assessment (LCA) methodology was used contemplated inside the procedure ISO 14040-2006 and ISO 14044-2006 with the new paradigm "from cradle to cradle" to quantify the entering and leaving flows in each of its stages. The stages included In the LCA were: cultivation, crop, post crop, benefit and preparation of the fruits, oil extraction process, esterification, biodiesel use in automobiles; as well as emissions and liquid unloading in all the stages; carbon life cycle closes with the reincorporation of gases (CO<sub>2</sub>) to crops via photosynthesis.

The impact categories evaluated in this study were: climate change, acidification, eutrophication, photochemical oxidants formation, respiratory effects and non-renewable energy, giving as result the environmental profile from which it can be obtained the solutions oriented to the reduction of the consumption of energy and emission generated throughout the life cycle of the biodiesel obtained from palm oil

## Sustainable Manufacturing and Mining I

SDEWES.2009.084

### **Sustainability Assessment for Brownfield-regeneration. A Survey of Methods and Tools**

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#### **ABSTRACT**

The EU Soil Thematic Strategy aims at an adequate level of protection for all soils in Europe and a harmonization of the diverse EU politics on soil. Specifically it calls for the application of sustainability concepts and methods as part of a harmonized, integrated policy to prevent further soil degradation and to increase the re-use of brownfields. There is a set of tools available for the sustainability assessment (SA) of brownfield regeneration projects, for example the 'Land-Value-Balance-Sheet' (developed by the German EPA), the Sustainability Assessment Tool of RESCUE (a multi-year research programme under EU's FRP5) or the multi-criteria approach currently developed at the US-EPA (STELLA). How do these approaches compare in concepts, methods and procedures? What are their aims and target groups? How do they fit into existing decision support and land-use planning procedures? Are there general criteria to measure the quality of SA tools? And how do these tools compare based on this criteria? These are the questions addressed and subsequently answered in this paper. The overall goal is to provide a comprehensive overview and meta-analysis on existing SA tools for brownfield regeneration in Europe and the U.S.

SDEWES.2009.381

## **Sustainable Mining and Recultivation**

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### **ABSTRACT**

Kolubara Coal Company are producing about 30 millions t of coal and digging about 70 millions m<sup>3</sup> of overburden per one year. From Kolubara coal is producing more then 50% of electricity in Serbia. Every year bucket wheel excavators are excavating few km<sup>2</sup> of lands in front of the open pit mines and stackers are making equivalent surfs of dumps. Sustainability development requirements recultivation of dumps. It is very serious task.

SDEWES.2009.141

## **Possibility of CO<sub>2</sub> Emissions Decreasing in Cement Industry**

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### **ABSTRACT**

The cement industry contributes about 5% to global anthropogenic CO<sub>2</sub> emissions, and is thus an important sector in CO<sub>2</sub>-emission mitigation strategies. Carbon dioxide is emitted from the calcination process of limestone, from combustion of fuels in the kiln, and from the coal combustion during power generation. Strategies to reduce these CO<sub>2</sub> emissions include energy efficiency improvement, new processes, a shift to low carbon fuels or waste fuels in cement production, increased use of additives in cement production, alternative cements, and CO<sub>2</sub> removal from flue gases in clinker kilns.

Increased use of fly ash as an additive to concrete has a number of advantages, the primary being reduction of costs of fly ash disposal, resource conservation, and cost reduction of the product. Since the production of cement requires a large amount of energy, about (2.9±3.2 GJ/t), the substitution of cement by fly ash saves not only energy but also reduces the associated greenhouse gas emissions.

The paper evaluates the reduction of CO<sub>2</sub> emissions that can be achieved by these mitigation strategies, as well as by partial substitution of cement by fly ash. The latter is important because the quality of the produced concrete depends on the physico-chemical properties of the fly ash and thus partial substitution as well as the type of fly ash (e.g. the content of CaO) have an effect not only on energy consumption and emissions, but also on the produced concrete quality.

SDEWES.2009.444

## **Development of Biological Systems for Monitoring, Removal and Recovery of Chromium and Mercury**

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### **ABSTRACT**

The effect from exposure to toxic chromium is depending on the state of oxidation of the metal. The hexavalent chromium is toxic to all the organisms, while the trivalent chromium has a lower toxicity. This toxicity is related to the process of reduction of Cr(VI) to the lowest oxidation states in which free radicals are produced. Some microorganisms and plants have the ability to concentrate large amounts of heavy metals and are used as biosorbent for metal monitoring and recovery, for treatment of urban and agro-industrial wastewater, and for remediation of water and soil. Here, to study the bioadsorption of chromium the algae *Spirulina maxima*, the yeast *Saccharomyces cerevisiae*, and the plant *Vetiver zizanioides* were tested. For each biological system we have identified and optimised biochemical and kinetic variables in order to highlight the critical parameters, such as time and pH, to improve the efficiency of the system also in function of Cr(IV) to Cr(III) speciation. Positive data of analytical utility were obtained with the alga after 60 minutes and with the yeast after 90 minutes of exposure. Preconcentration gives the best results with algae after 120 and 180 minutes. For environmental applications and bioremediation positive results were achieved with the plant *Vetiver*. As a result, these systems can be proposed for analytical purpose and environmental remediation. The good performance and the optimisation of the methods for chromium removal also suggest the applicability of the same biological systems to the bivalent free or compelled mercury (i.e. methyl-mercury).



## Solar Thermal Heat and Power II

SDEWES.2009.604

### Solar Tracking System for Rural Parabolic Concentrators in Chad

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#### ABSTRACT

Chad is living an heavy energetic crisis due to prohibition in using the wood coal for the daily energy needs. Is increasing the use of dry wood for cooking with the result of rapid growth of deforestation rate.

The EU is working to stop this phenomena financing many projects to stimulate the use of alternative resources.

In the framework of the EU Project for 'Participatory Management of Forest Resources and Promotion of Economic and Eco-compatible Initiatives in the Vallée du Logon' about sixty Solar Parabolic Concentrators were distributed to the population.

The concentrators are plagued by many problems. The most significant was found to be the solar orientation: when using the concentrator you should periodically repositioning the plate to maintain a high efficiency. If this is not, the time of use becomes unsustainable. Many concentrators are no longer used.

A system of automatic solar orientation that enhances the efficiency of existing concentrators is proposed. It is applied to the existing structure as an addition to minimize the costs of the intervention. It is made of materials readily available and very cheap.

The analysis of solar diagrams shows that it is possible to use a mono-axial (N-S oriented) handling system with a negligible loss of yield. The angular velocity of the sun at the Earth's surface is about 0.26 rad/h during the whole year. In the 6 hours of daily interest is swept a mean angle of 90 degrees.

The system designed comply with the approximations already taken. It allows the concentrator to maintain the proper position during the whole 6 hours/day taken in consideration. This movement is made by a simple properly calibrated sand hourglass system.

A weight, resting on a cap and connected to a chain of bike tight by a small counterweight, will come down slowly because of the emptying of the hourglass full of sand. A chain, combined with an existing cycling transmission crown will allow the concentrator to rotate.

An experimental law for the granular outflow was founded and used to estimate the exit section of the hourglass.

The energy and economic calculation shows that the full-time use of this type of parabolic concentrator allows the saving of 982 kg/year of firewood and 1.528 kgCO<sub>2</sub>/year are the avoided emissions related with a payback period of only 5 months.

SDEWES.2009.493

## **A Methodology to Study the Effect of Geometrical Dimensions of a Basin Type Solar Still**

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### **ABSTRACT**

A new radiation model for investigating the performance of a basin solar still is proposed which for the first time accounts for the effect of all walls on the amount of incident solar radiation to the base and water. The prediction of this model is in very good agreement with present data. Then, the effect of geometrical dimensions of the still on productivity has been investigated theoretically. The result shows the system efficiency decreases by increasing the height of solar still but it increases by extending the basin length. Further, by an increase in width of the still, at first the system efficiency increases to a maximum value and then it decreases. To maximize the annual efficiency, the width is suggested to be half of the basin length.

SDEWES.2009.137

## **Efficiency of Solar Ray Use by Parabolic, Cylindrical Solar Concentrator for Heat Production**

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### **ABSTRACT**

Long stationary parabolic, cylindrical solar concentrator for heat production consists of the aluminium absorber (with water pipes inside) and parabolic, cylindrical reflector (with metal surface) and has geometrical concentration ratio up to 4. It is of CP-180A type. Direct solar radiation approaches the concentrator aperture at different angles and pathways. For different aperture angles and different kinds and types of metal surfaces of the reflector, it would be investigated how efficiently the direct solar radiation reaches absorber to be converted to heat by using software CATIA.

## Hydro, Wind, Geothermal I

SDEWES.2009.244

### **A Scoping Study of The Potential for Micro-Hydropower in Aberdeenshire Scotland**

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#### **ABSTRACT**

Aberdeenshire in North East Scotland is a region of mixed farming, forestry and land for sporting shooting (hunting) and fishing. In the past, water power was very widely used in rural areas. Farms used water power to run mills for grain crops including for threshing and milling; forest owners or sawmillers used water power for sawmills; and many of the larger estates had small hydropower plants. In addition, water power was widely used in cloth and paper manufacture in both small and some quite large factories. The connection of outlying rural areas to the national electricity grid and the decline of rural manufacturing resulted in the closure and falling into neglect of many of these historic water power sources. In recent years, there has been a revival of interest in water power as new technologies offer prospects for low and high head hydropower generation.

This study uses hydrological data, archaeological records and a field survey of a sample of known former water power sites to estimate the potential of these sites for profitable hydropower production. The paper will present the interim findings of a multidisciplinary research programme undertaken in collaboration with Aberdeenshire Council and Highlandeco-Design, an engineering company specialising in micro-hydro.

First, the study reviews the historical evidence of the use of hydropower in the region. Second, it considers the available technologies for micro-hydro production. The policy and planning environment with respect to renewable energy is then assessed, with particular reference to hydropower development. The study then estimates, for a sample of sub-regions within the council area, the potential yield of energy from such sources, based on the use of Lowflow2000 to estimate water availability. It explains the basis of a field survey to feed information into a site suitability scoring system which has been developed based on expert knowledge of the principal factors impeding and facilitating hydropower development at a particular location. Such an approach gives a public sector body such as Aberdeenshire Council, which has a strong commitment to support renewables initiatives, a platform of knowledge to guide their policy of supporting renewable energy production.

SDEWES.2009.047

## **Future Changes of Freshwater Needs in The Electricity Production Sector: a European Study**

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### **ABSTRACT**

The future of Europe's waters will be influenced by a combination of many important environmental, socio-economic, energy-related, political, and policy drivers. The main drivers as such are climate change, population and economic developments, land use change, energy consumption as well as technological improvements.

The objective of this work was to produce quantitative estimates of freshwater used in the power production sector in Europe up to 2050 and to assess the impact of climate change and changing electricity consumption on future water resources. At the same time changing freshwater needs of other water use sectors, e.g. the domestic, manufacturing and agricultural sectors were taken into account. In order to attain the goals of this study, a scenario approach and a modelling approach were combined. Two scenarios were selected to cover the time horizon from the year 2000 (base year) to 2050: a baseline scenario reflecting a continuation of current trends and a climate policy scenario assuming policies to reduce greenhouse gas emissions. The scenarios were developed through a participatory process within the framework of the SCENES project and address the question on how Europe's waters will look like in the future. The modelling approach was selected to quantify the current and future European water use in the in a consistent way and thus support the scenarios. Here, the water model WaterGAP (Water - Global Assessment and Prognosis) was used as the tool to compute the scenarios for whole Europe.

In a first step estimates of annual water withdrawals and consumption in the electricity production sector were provided with a spatial resolution of 5 by 5 arc minutes for the base year and 2050 considering the location of thermoelectric power plants in Europe. Here we analysed the future trends in cooling water use compared to other water use sectors. Then, in a second step, further analyses on a monthly time basis were carried out focussing on river discharges during low flow seasons. Here low flow conditions were calculated to assess the impact of climate change on river discharges and were related to the future cooling water needs, especially for thermoelectric power plants using one-through cooling systems. In this study the low flow to cooling water needs ratio was used as an indicator to identify future hot spots where water is scarce and where problems of rising water temperature may occur.

SDEWES.2009.566

## **Hydrological Analysis in Trust (Life+ Environment Policy and Governance 2007) Project**

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### **ABSTRACT**

The River Basin Authority Alto Adriatico is the river authority responsible for the management of the rivers flowing into the Northern Adriatic Sea.

With the general purpose of contributing to the general objective of theme "Water policy" the paper contributes the experience gained in the European project TRUST - Tool for Regional-scale Assessment of ground water Storage improvement in adaptation to climate change (LIFE + Environment Policy and Governance 2007) that focuses on adapting the groundwater of the Italian Northern East plain to the adverse impacts of future climate change. TRUST is focused on laying the basis for increasing aquifer storage through managed artificial recharge (MAR) , also called "water banking". The project is based on the use of state-of-the-art technologies and methodologies for enhancing the knowledge and management of groundwater - e.g. hydro-geological assessment and modelling, remote sensing and GIS, climate change models, managed aquifer recharge.

The innovative aspect in TRUST consists in a different approach to the artificial aquifer recharge technique. Managed aquifer recharge has been carried out for many years to meet water demand under severe water scarcity conditions. TRUST promotes the water banking concept with the aim of anticipating future needs while restoring environmental conditions. Water banking makes use of the natural holding capacity of an aquifer to store water by means of artificial processes. In addition, TRUST has a high replicability potential that enables it to be easily applied to other regions of the world featuring appropriate geological conditions.

An overview and first result of the project are shown, focusing on the hydrological analysis that has been developed using an accurate and robust of the hydrologic response model. The model, of the geomorphologic - MonteCarlo type, reproduces stochastic and real hydrographs and thereby the return period of peak flows and of any other feature of engineering interest, including shapes and volumes. The salient geomorphic features of the basin is recovered by digital elevation model while the land cover analysis is based on data from remote sensing. The model captures the essential physics of the relevant processes, rather than merely reproducing a correspondence between inputs and outputs within a finite set of observations. So predictive capabilities and robustness of the model are showed.

SDEWES.2009.251

## **Comparison of Operating Efficiency of Electric and Gas Heat Pump Regarding to Renewable Energy Source**

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### **ABSTRACT**

Rational use and managing with energy is basic presumption of sustainable development. Economy with energy today is directed to using and promotion of pure technologies, with high energetic efficiency and using of renewable sources, and all in purpose of environmental protection.

During the last decade heat pump technology has attracted increasing attention as one of the most promising technologies to save energy.

Exactly, heat compressor pumps represent technology with high energetic efficiency. Heat pump is a device for moving heat from a low temperature heat source to a higher temperature heat sink using the power for compressor running. In most cases, electric engine runs the compressor.

The efficiency of electric heat pump is defined with Coefficient of Performance (COP - heating factor). It is defined as the ratio of heat delivered by the heat pump and the electric power for compressor running and auxiliaries. But, COP is not observed from primary energy source, it is observed after electroenergetic transformation. In this article the electric heat pump running will be compared with the gas heat pump running from primary energy source (PER- primary energy ratio).

PER is ratio between useful heating energy and primary energy. Gas heat pump uses a primary energy source without transformation in electric energy and has got a lower CO<sub>2</sub> emission. In this article, the major advantage of gas heat pump, the utilization of exhausted heat from gas engine (from cooling water and exhausted gases) will be described. Also, it will be described the two renewable energy sources: air and sea water with advantages and disadvantages.



SDEWES.2009.605

## **Impact of National Legal Frameworks on Increasing the Implementation of Small-scale Hydro Electricity Plants (SHP) in Europe - Experiences of Smart Project**

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### **ABSTRACT**

In the project SMART (Strategies to promote small scale hydro electricity production in Europe) from the programme IEE (Intelligent Energy Europe) 7 institutions from 5 European states participate: Province of Cremona – Italy; CESI RICERCA SPA – Italy; Faculty of Mechanical Engineering and Naval Architecture, University of Zagreb – Croatia; Karlovac Regional Authority – Croatia; Norwegian University of Science and Technology – Norway; Regional Secretariat of Attica - Greece and Energieagentur Waldviertel – Austria. The SMART proposal address to the complexity of the legal/administrative processes to obtain concessions and the economical/financial attraction of private investors. One of the main objective of the project SMART is to give clear contributions to pull down these non-technological barriers, as helpful tools for European, national, regional and local authority decision-makers for increasing the implementation of small-scale hydro electricity plants (SHP) on their own territory.

Therefore in this paper the results of investigations performed with aim to detection and pull down these non-technological barriers will be presented, both in partner states (Italy, Croatia, Norway, Greece and Austria) and states in their neighbourhood (Portugal, Spain, Serbia, Bosnia and Herzegovina, Bulgaria, Romania, Germany and Poland). Investigations include:

- analysis of inalienable principles regarding the right to use water;
- analysis of the normatives about SHP;

- analysis of environmental and administrative procedures (legal SHP definition, environmental impact assessment, obtaining the concession for use of the water, the authorization to build a SHP, the authorization to connect the plants to the electric grid);
- critical review of the different regulations (weak and strong points, most important conflicts linked to the use of water), in previously cited states.

In conclusion of the paper strategies to improve existing regulations (common methodology and tools) will be presented.

## Approaches to Sustainable Development: Methodologies II

SDEWES.2009.445

### **Environmental Data Management: National Polluted Sites Indicators**

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#### **ABSTRACT**

In Italy the Ministry of the Environment and Protection of the Territory and the Sea is the leading authority when it comes to planning intervention to remediate chemically and biologically contaminated sites that refers to all areas where, following previous or current human activities, an alteration of the land, surface and underground waters has been certified with concentrations exceeding standards established by regulations.

The Italian Decree 152/2006 and following amendment (d.lgs 16 January 2008, n.4) which replaces the former relevant Decree 471/1999, constitutes the core of the Italian legislation concerning contaminated sites. This Decree establishes rules for planning criteria, procedures and modalities for the environmental security, reclamation and recovery of polluted sites. The Ministry of the Environment relies on several Institutes that includes ISPESL: (National Institute for Occupational Prevention and Safety). This is a technical and scientific body of the Italian National Health Service and its main activities are research and training in public and workers' health.

Considering the environmental importance of these sites we have constructed indicators to give information on reclamation activities: safety measures, characterisation and risk analysis. Since the reclamation sites activity is very complex, indicators provide a more practical and economical way to track the state of the environment. Indicators are a useful tool for governments, non-government organizations and research institutions to communicate the state of the environment to the general public and decision makers.

In order to compute indicators an information system on contaminated sites data has also been developed. It allows powerful management of a greater number of information and permits fast and direct access to them.

SDEWES.2009.291

## **Environmental Systems and Sustainable Development in Physical Planning**

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### **ABSTRACT**

In modern societies all major development projects start off with expert proposals and political adoption of a relevant physical development plan. As we witness many of development and conservation discrepancies in our environment today, some major issues regarding the planning process must be emphasized. In order to take a greater step towards planning more sustainable solutions, it is necessary to build a framework for reaching better decisions in the early planning phase. As a part of the larger scientific project, environmental system of Konavle area in Croatia was analysed by means of interdisciplinary research. Case study carried out on Cavtat urban area points out that recent and planned urban growth is increasingly disregarding environmental values and vulnerabilities. Results and methodology presented in this paper are submitted for consideration to both physical and landscape planners, since the quality of planning decisions, primarily in the field of natural resources exploitation; biological and landscape diversity, soil, water and wind, is of critical importance for sustainable development.

SDEWES.2009.241

## **A Prediction of The Exergy Loss of World's Mineral Reserves in The 21<sup>st</sup> Century**

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### **ABSTRACT**

This paper makes an assessment of the exergy loss of the main produced minerals in the world throughout the 21<sup>st</sup> century, namely for coal, oil, natural gas, iron, aluminium and copper. The reason for using the exergy analysis as an assessment tool is because it takes into account the main physical features that make a natural resource valuable: concentration, composition and quantity. Furthermore, using the same unit of measurement (energy) allows comparing and adding all minerals considered. The prediction of the mineral reserves has been accomplished with the help of five different scenarios. The first scenario assumes that production of all commodities will follow the well known Hubbert's bell shaped curve. The other four models are based on the IPCC's SRES scenarios for fossil fuel consumption and the Hubbert peak model for non-fuel minerals. The results of this study show that there might not be enough resources for satisfying the predicted future mineral demand.

SDEWES.2009.197

## **Visualizing Energy Security: an Analytic Hierarchical Process Approach**

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### **ABSTRACT**

Energy security can be defined as the reliable supply of energy at an affordable price (IEA 2001). Unlike climate change, energy security has no easy method of measurement. Greenhouse gas emissions can be measured quantitatively and expressed in terms of their global warming potential; however, the same cannot be said for energy security, as it is a qualitative rather than quantitative measurement.

Despite this limitation, a tool that supports the ranking of different energy sources used by a jurisdiction in terms of their relative importance to its economic and social health. Such a ranking would give the public, policy-makers, and politicians a clearer understanding of the jurisdiction's energy mix and the state of its energy security.

This paper proposes a means of ranking energy sources using Analytic Hierarchy Process (or AHP), a multi-criteria decision analysis technique commonly used for energy and environmental modeling. The design employs three criteria: supply, infrastructure, and affordability, which are applied to the energy sources consumed by the jurisdiction or energy services within the jurisdiction. The resulting ranking produces an energy security index for each energy source; the higher the ranking, the more secure the source. The ranking, when used in conjunction with the consumption associated with each energy source, can be displayed graphically to permit a rapid visual interpretation of the state of energy security in the jurisdiction.

The paper includes a detailed discussion of how AHP was used to allow qualitative information to be converted into a measured index of energy security. Case studies from several jurisdictions are presented and analyzed through the specially developed energy security analysis software. Other uses of the tool are also discussed, including as a scenario tool to consider ways of improving energy security by changing the energy mix.

SDEWES.2009.457

## **Modelling the Dependence Structure Between Crude Oil and Refined Products**

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### **ABSTRACT**

We investigate the asymmetric dependence structure between the price returns from crude oil and refined products. In most applications, this relationship is modeled in the level form by estimating the long-run relationship between the prices using standard and asymmetric error correction models with mixed evidence. We contribute to the literature through the use of copulas for modeling the complex structure between crude oil and various refined products in this closely dependent integrated market. Investigating the nonlinear relationship between the return series via the application of different copula functions gives us a better representation of the dependence structure. We find that in particular in the tails of the distributions the use of correlation as the only measure of dependence clearly underestimates the risk of joint extreme price movements. On the other hand, copula models represent a more general method for deriving the nature of dependence and provide an appropriate fit also for the tails of the bivariate distributions. Our results have important implications for hedging and risk management for the refined petroleum industry.

## Advances in Waste Management III

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SDEWES.2009.286

### **Performance Analysis of Energy Recovery in An Italian Municipal Solid Waste Landfill**

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#### **ABSTRACT**

In this paper an Italian municipal solid waste landfill has been analyzed. The plant, operating since 1998, was designed for landfill gas energy recovery. The aim of this paper is to analyze the performance of this system during its operating time; the authors will also analyze an alternative solution, based on fuel cell technology. The two solutions studied will be compared. An economic analysis will be performed, considering the cost-effectiveness of the current solution in comparison with a solution based on the molten carbonate fuel cell technology, particularly suitable for landfill gas (LFG) energy conversion. The economic analysis will take into account some environmental externalities, such as air pollution externalities, generally not considered in traditional economic profitability assessment. This with the aim of identifying the most economic and sustainable technology for the case studied, as well as providing some new insights regarding LFG energy conversion.



SDEWES.2009.309

## **Microwave Pyrolysis, a Novel Process for Recycling Waste Automotive Engine Oil**

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### **ABSTRACT**

Used automotive oil was treated using a microwave-induced pyrolysis process, with the intention of assessing the suitability of the process in recovering valuable products from this otherwise difficult to dispose of waste. The resulting pyrolysis gases were condensed into liquid oil; the yield and composition of the recovered oil and remaining incondensable gases was determined, and these were compared with those arising from fresh oil. Process temperature was shown to have a significant effect on the overall yield and formation of the recovered oils. The recovered liquid and gaseous pyrolysis products contained various light hydrocarbons which could be used as valuable industrial feedstock. Our results indicate that microwave pyrolysis shows extreme promise as a means for disposing of problematic waste oil. The recovery of valuable products shows advantage over traditional, more destructive disposal methods, and suggests excellent potential for scaling the process to the commercial level.

SDEWES.2009.337

## **Health Care Waste Production: Measures and Estimates in "V. Cervello" Hospital, Palermo, Italy**

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### **ABSTRACT**

A monitoring work was carried out in May/June 2007 in one large hospital located in Palermo. The monitoring consisted in weighing the infectious waste containers filled in some Departments purposely chosen. As a second stage of the work a comparison was attempted between the results obtained from the waste production monitoring and the Health Care Facility's purchases recorded in the same time. A restricted list of purchased products out of the general one was extracted. Such list allows one to calculate approximately the mass of medical devices purchased and their composition. To these materials a reasonable change in humidity after use was attributed. It was possible in this deductive way to draw a probable composition of health care waste materials, which is forbidden to ascertain by direct inspection.

SDEWES.2009.376

## **Syngas Production by Three-stage Gasifier Fed by Municipal and Industrial Wastes**

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### **ABSTRACT**

Aim of this paper is to evaluate the possibility of producing a clean syngas that can be directly injected in a Reactor for obtaining Methanol or DiMethylEther (DME) starting from a blend consisting of civil and industrial wastes.

The combined use of civil and industrial (no-dangerous) waste in gasifiers meets problems because is very difficult to obtain an homogeneous blend. The problems can be solved by drying of wastes by crushing them into the ball-mill at high-speed. In succession, a pyrolysis is performed into a vessel in which a gasification does not occur. The facility can be considered as a gasifier at two-stage, already tested at bench scale successfully, with an additional vessel (stage one). In this way a gasifier at three-stage is constituted. As a consequence, the three-stage gasifier consists of a stage in which the pyrolysis is performed separately from the gasification process, which is developed in stage two. The products of pyrolysis reach stage two where are gasified to produce a crude syngas containing tar and C<sub>2</sub>, or higher hydrocarbons. In agreement with the experimental data concerning the two-stage gasifier, CaO and Na<sub>2</sub>CO<sub>3</sub> were added into stage two. In this way the content in chlorine and sulphur of syngas is assured to be under the legal limits. The three-stage transforms crude syngas in clean syngas because the content of tar and C<sub>2</sub> (or higher hydrocarbons) is reduced under the law limits. This stage, in fact, works as second stage of two-stage reactor. The need of enthalpy of the pyrolysis stage is solved by heat exchange with syngas that leaves, at a temperature of about 800°C, stage two. The syngas flows into an external jacket surrounding stage one. This allows at reaching a temperature ranging from 300 up to 400°C in the stage one. It allows also the cooling of the syngas to a temperature nearer the working temperature of the Reactor located at downstream.

Besides, preliminary evaluations indicate that an additional advantage of such a reactor, respect to the two-stage gasifier, is the lesser amount of oxygen or air, which means a higher content of CO and H<sub>2</sub> in syngas and a higher efficiency in the yield of Methanol/DME. That means that also the amount of CO, by-product of the Methanol synthesis, is increased. Therefore also an additional energy, i.e. electric power, is so obtained.

## Sustainable Transport I

SDEWES.2009.097

### **Energy Efficiency in Transport and Mobility from An Ecoefficiency Viewpoint**

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#### ABSTRACT

Transport is the disease of the ecosystem in our time and it is becoming the principal ailment of the global ecosystem. The strategic objective the European Union has declared to pursue with the White Paper on Transport is to work towards the so-called decoupling of economic growth and transport growth. The energy policies of the different EU countries in the transport sector promote urban mobility plans, the renewal of the fleets of cars and industrial vehicles, the introduction of biofuel, etc. Today, mobility is considered an achievement of developed society. Sustainable mobility is achieved when it is accepted that not everything in society must be measured in terms of the speed of arrival and currently accepted monetary costs. Transport is a sector that is at the service of the remainder of economic activities, allowing them to approach the production and consumption centres. However, from the point of view of Ecoefficiency and the Life Cycle Assessment (LCA), energy policies must go further. They must be capable of not only monitoring the excessive increases in energy consumption that this sector experiences year after year, but also actually reducing them.

The objectives of this paper are to analyse the current transport model and the policies on energy efficiency being promoted in the EU from a LCA point of view. It special attention will be paid to the private vehicle, the environmental impact of the stages of manufacture, use and disposal, and the consequences of the plans to renew fleets. How old should a vehicle be so that, when it is changed, the energy embodied in the materials of the vehicle is less than the gain in energy efficiency due to changing the model? How does the rebound effect affect the private car sector? What is the market trend in sizes and engine specifications? Another objective of the paper is to analyse the different means of transport in the energy consumption-time ratio from an LCA viewpoint. Reducing times in transport leads to greater energy consumption, but how long does nature take to repair the environmental damage caused?

The results will be compared with the current transport style, providing, from an LCA viewpoint, the steps towards a more sustainable transport and mobility model.

SDEWES.2009.227

## **Advanced Measures for Companies to Increase Public Transport Use**

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### **ABSTRACT**

There are many untapped opportunities to save energy and encourage the use of renewable energy sources in Europe. The Intelligent Energy - Europe programme is the EU's tool for funding action to improve these conditions and move us towards a more energy intelligent Europe. BENEFIT is three-year project under IEE programme, which will implement many different applications in 7 different cities throughout Europe. Author of the article would like to introduce the project and its innovative concept and approach during the conference.

Europe-wide motorised individual traffic is on the rise despite the fact that fuel costs increase continually and even dramatically. Obviously, energy-efficiency and environmental awareness are contradictory to the need of individuals to drive to work in their personal car. To counteract this trend by promoting attractive alternatives in the area of public transport, is one of BENEFIT's most important tasks. Therefore one of the project's approaches is to take up previous know-how and to exchange experience effectively among the partner cities. There is a focus on the effective involvement of the key market players in each of the cities. Within demonstration actions like raising awareness, optimising information, organising new and improved services and effective actions to motivate the commuters to change travel behaviour, the cities can disseminate and promote the project. The main objective is to show companies and their employees the attractiveness of public transport systems compared to car use. Especially in the New Member States private car ownership is rising rapidly. BENEFIT will address this issue and aims to achieve a modal shift from the car back to public transport, and in the process, achieve substantial energy savings, emissions reductions and cost reductions.

Each BENEFIT city possesses its individual challenges in the area of traffic. Measures of BENEFIT, devised and implemented by the cities, are coordinated accordingly. However, all actions result from the same intention, namely to inform about public transport, to motivate new and existing users and to carry out necessary organisational improvements.

SDEWES.2009.451

## **Evaluation of Plug-in Hybrid Electric Vehicle Considering Driving Pattern and Optimal Power Generation Mix**

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### **ABSTRACT**

Evaluation of clean energy vehicles is taken for this presentation. Reducing the CO<sub>2</sub> emission in transport sector is very important since around 20% of the total CO<sub>2</sub> emissions in Japan are produced from automobiles. We focused on 50 million ordinary passenger cars which fuel is now monopolized by gasoline. There is a wide range of technological options to reduce CO<sub>2</sub> emissions of passenger cars. Then, we focused on plug-in hybrid electric vehicle (PHEV) because PHEV is expected to be deployed commercially in near future. The purpose of this study is to analyze economic advantages and ecological effects of PHEV in Japan considering driving pattern and electricity supply mix in detail.

We used the data in the survey of origin and destination of automobiles (OD survey, hereafter) by Ministry of Land, Infrastructure, Transport and Tourism, Japan for categorizing driving patterns of ordinary passenger cars. According to the OD survey in 2005, all trips in a day are counted for ten different purposes of the trips for weekdays and weekends respectively. Data is available in the OD survey for the distribution of trip lengths for each trip purpose. As simulation results we obtained the distribution of daily driving length of passenger cars. Then, we decide the capacity of battery for PHEV through the analysis of relative fuel economy of PHEV. On the basis of the assumptions for the costs of batteries and other PHEV components, we estimate the market shares of PHEV in future; then, we estimate the increase in electricity demand caused by the introduction of PHEV with changes in load profile assuming several different modes for charging battery. Taking into account the modified load profile, we calculate the optimal power generation mix to estimate the increase of CO<sub>2</sub> emission by the electricity generation for charging PHEV; thus, to evaluate the total CO<sub>2</sub> emissions of passenger cars including both direct emissions from fuel combustion and indirect emissions through power generation. Time horizon for the analysis is 2005-2050.

SDEWES.2009.368

## **Survey and Evaluation Concerning the Use of Eltis, Europe's Number One Web Portal on Urban Transport and Mobility**

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### **ABSTRACT**

ELTIS (European Local Transport Information Service) is an initiative of the EU, DG TREN. It aims to provide decision-makers, practitioners, researchers & lecturers with the best available information on urban transport. Whenever possible, it makes sense to use existing knowledge - why re-invent the wheel? The free of charge service contains EU-project results and findings, news around Europe, case studies of implementations, policy papers, a conference / event database, tools for practitioners

ELTIS provides free multilingual teaching materials for downloading based on EU-project findings. It includes written materials, slides, audio tracks, etc.. Materials for the following topics have been developed: Public transport (Benchmarking & quality management), integrated transport chains, traffic management, safety, modelling, environment, energy & transport, pricing, mobility management, urban freight transport, transport & land use, policy formulation, alternative fuels and cycling & walking

The didactic structure enables their use in different types of learning formats. They are designed to be both mutually complementary and adaptable to the relevant teaching goals / instructional settings.

ELTIS has started in 1998 and is developing rapidly. Before 2006 the news section contained between 5 news items per month. In 2007 an average of 6.7 news items per week were published (ca 1 per day, 365 days / year).

The strong imbalance of news from W-, N- and Central Europe, which was about 90% at the start of 2006 is going to be changed. In mid 2008 news from S-Europe and from the New Member Countries (NMS) / New Neighbouring Countries (NNC) already comprises 30%.

A similar development occurs case studies. In 2006, 420 case studies were on-line. Now the number has tripled to 1400. Very promising is the fact that case studies from the NMS & NNC are increasing rapidly. But it was initially difficult to convince the actors in these countries to share their experience. However, as more case studies from NMS are put online, others see that they too have similar good practice to share, and so there has been something of a 'virtuous circle' in the addition of new case studies from these countries. This development is promising and meets exactly our aims.

It was also an objective to motivate researchers and practitioners from NMS and NNC to participate in EU-funded activities / projects. 1<sup>st</sup> evaluation results show a positive tendency (evaluation still ongoing)

SDEWES.2009.453

## **Preliminary Experimental Evaluation of a Four Wheels Motors, Batteries Plus Ultracapacitors and Series Hybrid Powertrain**

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### **ABSTRACT**

This paper reports the preliminary experimental evaluation of a four wheel motors series hybrid prototype equipped with an internal combustion engine coupled with a generator and an energy recovery system (batteries plus ultracapacitors). The paper analyse global efficiency (energy dissipated to overcome the dissipative forces on energy dissipated in fuel), autonomy in electric configuration, and the efficiency of the regenerative braking system. The tests were carried out in a test cell equipped with a chassis dynamometer and a Constant Volume Sampler system. The tests were performed according to the current regulated procedures and therefore. A constant speed test was performed in order to evaluate the autonomy of the vehicle in the electric configuration. The results shows that the real tank to wheels efficiency is about 30% for HOST as a series hybrid and 79% for HOST as an electric vehicle.



## Hydro, Wind, Geothermal II

SDEWES.2009.633

### **Investigation of Wind Energy Potential for Possible Electricity Generation At the Selected Location in Bosnia and Herzegovina**

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#### **ABSTRACT**

Due to limited reserves of fossil fuels on one side, and the need for environmentally friendly electricity generation on the other side, it is necessary to research the possibilities for utilization of renewable resources in Bosnia and Herzegovina. One of the possible useful renewable sources is wind energy. The research is aimed at creating a basis for possible utilization of wind energy for the purpose of electricity generation at the selected location (on the mountain Ivan Sedlo - 45km from Sarajevo) in Bosnia and Herzegovina. Within this research of available potential of wind energy at location, the knowledge of local atmospheric flows has a crucial role for the installation of wind generators at this location.

Since September 2007 Faculty of Mechanical Engineering of University of Sarajevo conducted measurements of wind characteristics with a 30 m measurement mast. In this paper, measurement data for the first 8 months will be analyzed and based on them and selected wind turbine, annual electricity generation will be estimated and simple economic pre-feasibility analysis will be made.

SDEWES.2009.522

## **Eastern and Southern Serbia Wind Energy Potentials**

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### **ABSTRACT**

The main goal of this paper was to obtain the best possible locations for siting of wind turbines, with the final goal of making the wind atlas of Serbia. In this phase, nine mezzo and twelve micro models are considered, which mostly cover the area of Eastern and Southern Serbia. The simulations are mostly performed using the WAsP simulation software, considering the conclusions obtained in the elaboration of the mentioned specific methodology. The results are compared by means of the turbine type, quality and quantity of the wind data and load factor. Finally, the economical analysis of the acceptability of the installing of wind turbine farms was done.

SDEWES.2009.424

## **Fracture Behaviours of HSLA Welds Made on Penstock's Material**

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### **ABSTRACT**

The aim of this paper is the experimental study of fracture behaviour of HSLA undermatched welded joints made on penstock's material, and also to determine relevant parameters which contribute to higher critical values of fracture toughness. High strength low alloyed (HSLA) steels are often used as materials of penstocks at hydroelectric power station for build up of multi pass welded joints. Welding of HSLA steels to produce undermatched weld joints presents a technological challenge for modern welded structure production.

Undermatched welded joints are used for repair welding of joints damage during hard operation conditions or by short-period overloading. They are recommended to prevent hydrogen cracking with preheating, specially for welded joints made of HSLA steels with yield strength above 700 MPa.

Crack tip opening displacement (CTOD) as a fracture toughness parameter is determined as the lowest toughness of different microstructure along crack front, according to the weakest link model.

The presence of different microstructure along pre-crack fatigue front has important effect on the critical crack tip opening displacement (CTOD). This value is the relevant parameter for safe service of welded structure (penstocks). In the case of specimens with through thickness notch partly in the weld metal, partly in the heat affected zone and partly in the base material, i.e. using the composite notched specimen, fracture behaviour strongly depends on a portion of ductile base material, size and distribution of mismatching factor along vicinity of crack front.

SDEWES.2009.124

## **The Geofar Project**

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### **ABSTRACT**

Deep Geothermal Energy has a high potential in Europe, that is not enough exploited yet. It becomes necessary to understand why. As technologies are constantly in progress, the project GEOFAR (Geothermal Financial and Awareness in Europeans Regions) aims to work on non-technical barriers, focusing most particularly on financial aspects. A consortium of European partners from Germany, France, Greece, Spain and Portugal since September 2008 works on overcoming these barriers. Studying cases (operating, planned and failed projects) is the basis of an analysis of difficulties encountered, without leaving aside the factor keys of success. Interviews with well-identified stakeholders (public or private investors, financial institutions, local, regional and national governments as well as runners of geothermal power plants) will help sharing experiences on European non-technical barriers in geothermal energy projects across Europe and improves the know-how and awareness on geothermal energy among the European stakeholders.

A special attention is made on analysis of financial mechanisms, existing in different European countries. On this basis it will be possible to propose new targeting financing and funding schemes, in order to reduce financial barriers hindering the initial stages of geothermal energy projects what is the main objective of the GEOFAR project. The proposed financing and funding schemes will be undergone in a reality check with banks, financial institutions and investors on the basis of a due diligence on real cases. These solutions will be completed by proposals for geothermal related legislations, directives and communications, in order to boost the development and investment in new energy projects.

The broadly disseminated results of GEOFAR promote and raise awareness of emerging geothermal applications. This project, launched by the Intelligent Energy - Europe II programme, European Union's tool to promote, energy efficiency and renewable energy in Europe, should make sure that geothermal energy will be considered as a relevant mean toward a sustainable, competitive and secure energy in Europe.

SDEWES.2009.583

## **Possibilities of Electric Power Generation in The Republic of Croatia from Medium Temperature Geothermal Sources**

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### **ABSTRACT**

As early as 1998, the Energy Institute “Hrvoje Požar” prepared a Program of Geothermal Energy Usage in the Republic of Croatia, which shows that in the Republic of Croatia there are several medium temperature geothermal sources with relatively low temperature of geothermal water in the range from 100 – 140°C, by means of which it is possible to produce electric power, e.g. Lunjkovec (125°C), Ferdinandovac (125°C), Babina Greda (125°C) and Rečica (120°C). However, only recently concrete initiatives for the construction of geothermal power plants have been started.

For the generation of electric power from medium temperature geothermal sources, the binary plants come to the fore, either with the Organic Rankine Cycle (ORC) or with the Kalina Cycle. In literature the Kalina cycle is cited as thermodynamically more favourable than the ORC, which reaches higher thermodynamic efficiency and gives more power. On the other hand, knowledges of the authors published in previous papers, obtained on the basis of calculations for medium temperature geothermal source in Croatia (Velika Ciglena) with relatively high temperature of geothermal water (175°C) are opposite. The ORC is thermodynamically better than the Kalina cycle. It was explained by relatively high temperature of geothermal water and relatively high average annual temperature of cooling air in condenser (15°C), which has more unfavourable influence in the Kalina cycle than in the ORC. Now, in this paper the comparison of the ORC and Kalina cycles will be performed for medium geothermal field with relatively low temperature of geothermal fluid (125°C) and relatively high average annual temperature of cooling air in condenser (15°C): concretely for geothermal field Lunjkovec, probably one of the first future geothermal power station in Croatia. The comparison of ORC and Kalina cycles will be performed on the basis of results of energy analysis. Aim of the comparison is to propose the most suitable binary plant either with the ORC or with the Kalina Cycle for medium temperature geothermal sources in the Republic of Croatia with relatively low temperature of geothermal water.

## Approaches to Sustainable Development: Case Studies

SDEWES.2009.017

### **Multi Criterion Evaluation for Application of Renewable Energy and Energy Efficiency Policies in The Lerma Valley, Salta, Argentina**

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#### **ABSTRACT**

This paper evaluates the application of renewable energy and energy efficiency methods in a territorial planning for the Lerma Valley, Salta, Argentina.

For identifying the possible energetic applications or policies to be used by the urban or rural people a survey to experts was made. The advisors opinion was used for defined and evaluate the weight indicators organized by environmental impact, risk and aptitude. We understand for: Aptitude, all the conditions favorable to the implementation of a technology or an energy efficiency policy. Environmental impact is the predictable effects motivated by the actions. Risk, are all the conditions that can restrict the technology transfer.

The multi criterion evaluation (MCE) is a matricial base with a solution by the application of a weighed lineal sum. The matriz is made with the advisors opinions, the feelings of the social actors and the renewable energy map of the area available.

The MCE shows the principal applications that should be promoted in the Lerma Valley, that are: energy efficiency as environmental education, strategic planning, energetic saving; solar technology as solar fruit or vegetable dryers, solar water collector, bioclimatic architecture, solar cookers; hydraulics technology as water pum; biomass energy technology as produccion of biogas (sewage water and urban solid waste).

SDEWES.2009.161

## **An Investigation of The Sources of Industrial Energy Use Change in The Japanese Economy**

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### **ABSTRACT**

This paper suggests a new approach -the Multiple Calibration Decomposition Analysis (MCDA)- to investigate the sources of industrial energy use change in the Japanese economy. The multiple calibration technique is utilized for an ex post decomposition analysis of structural change between periods, enabling the distinction between price substitution and technological change for each sector. The paper explains the theoretical properties of MCDA and applies it to an empirical case -the change in energy use in Japanese industry from 1970 to 1990. This paper clarifies how industrial energy use was affected by price substitution or technological change through the experience of the two oil crises, focusing on energy-intensive industry. The paper shows that technological change played an important role in reducing industrial energy use in the Japanese economy.

SDEWES.2009.003

## **Is the German Energy System Sustainable?** **An Analysis Based on The German** **Sustainability Strategy**

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### **ABSTRACT**

The World Summit on Sustainable Development (WSSD) in Johannesburg 2002 reaffirmed the conclusions of the 1992 UN Conference on Environment and Development in Rio and of the Brundtland Report that sustainable development is a crucial element for the future of the world and a keystone of the international agenda.

Since the publication of the Brundtland Report, the sustainability concept and its implementation have been discussed by the science community and society. Sustainability is regarded as a solution for society's present and future problems. To determine whether we are working in a sustainable way, we need information about the condition of the system earth. Sustainable development indicators describe and define issues and circumstances which characterize sustainable development. Sustainability indicators measure the difference between current conditions and a reference situation defined as sustainable. The availability of indicators is a precondition for the conversion of the model of sustainable development into specific policies.

Energy already plays an important role for sustainable development in the Brundtland Commission's report. The use of energy facilitates, on the one hand, economic development and prosperity but, on the other hand, the production and consumption of energy has negative consequences for the environment (e.g. climate change).

For our analysis, we developed a new Indicator for Sustainable Development (ISD) in order to analyze the German energy system. We also developed a quantitative sustainable development pathway for the energy system on the basis of the scientific work done by the German Federal Government. The analysis shows that developments in the energy system can be described with the help of measurable sustainable indicators and that the indicators identify the need for political action in the German energy sector and thus provide a starting point for political measures.



SDEWES.2009.283

## **Eco-efficiency Improvements in Turkish SMEs**

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### **ABSTRACT**

This article explains the results of the research project “Parallel Development of Industrial Productivity and Environmental Performance at SME’s Level”, which was executed by National Productivity Centre of Turkey and supported by The Technological Research Council of Turkey. The aim of the project was to develop both the productivity and environmental performance simultaneously in SMEs level by applying low cost and simple eco-efficiency measures. The project also aimed to bring up the eco-efficiency concept for SMEs, demonstrate some case studies and in this way to disseminate eco-efficiency practices, explain the environment-productivity relationship and implement case studies for 5 pilot companies.

SDEWES.2009.409

## **Review of Existing Energy Management Standards and Possibilities for Its Introduction in Serbia**

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### **ABSTRACT**

Until recent times, energy management practices primarily consisted in replacing inefficient equipment and then using any number of methods to estimate obtained savings. Experience shows that positive effects of energy efficient improvements were decreased over time. There have been significant efforts over the last decade to define appropriate standards and best practices and implement the consistent energy management system to increase and maintain that energy savings. The knowledge gained from thousands of energy efficient projects is driving a transition from traditional tactical practice (one-time "build and forget" projects) to energy management strategies proposed and endorsed by a number of international organizations. The current status of energy management standards development internationally, including an analysis of their shared features and differences is presented in this paper.

The purpose of the analysis is to describe the current state of 'best practices' for this emerging area of energy efficiency policymaking in order to study the possibility of implementation of energy management standards in Serbia and to estimate the effects and the potential for energy saving that would be made by its implementation.

SDEWES.2009.180

## **Technology Transfer: a 'Win-win' Strategy for Sustainable Development in Kenya?**

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### **ABSTRACT**

The aspect of how to respond to climate change and ensure Sustainable Development (SD) are currently high on the political agenda among the world's leading nations. In many cases, it is uncritically assumed that there is an automatic synergy of climate and development policies, particularly in the case of Greenhouse Gas (GHG) emission reduction. However, the transfer of environmentally sound technologies in the context of climate change mitigation is a really complicated problem. The key challenge is that low-carbon sustainable technologies need to be adopted both by developed as well as developing countries, in an effort to avoid past unsustainable practices and being locked into old, less sustainable technologies. Technology Transfer (TT), as an important feature of both the United Nations Framework Convention on Climate Change (UNFCCC) and its Kyoto Protocol can play a key role. TT can allow countries to move quickly to environmentally sound and sustainable practices, institutions and technologies. The main aim of this paper is to present results obtained from an elaborated stakeholders' assessment on Kenya's high priority energy needs and sustainable energy technologies fulfilling these needs in order to assist Kenya in finding ways of encouraging TT that would contribute to a low-carbon sustainable energy development. In addition, the sustainability benefits to be delivered by selected technologies along with the main barriers hampering their successful TT were explored.

The research presented is mainly based on the 'ENTTRANS, The potential of transferring and implementing sustainable energy technologies through the Clean Development Mechanism of the Kyoto Protocol' FP6 project, funded by the European Commission. The case study countries of ENTTRANS are Chile, China, Israel, Kenya and Thailand.

## Social Aspects of Sustainable Development

SDEWES.2009.061

### Supply of Renewable Resources from Tropical Forests to Poverty Stricken Communities

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#### ABSTRACT

The forests of the Congo Basin extend over an area of 228 Mkm<sup>2</sup> creating the second largest continuous complex of tropical forest in the world. Not only the forests contribute to the balance of global climates, storage of carbon and the composition of the atmosphere but they also create unique ecosystems to accommodate rich and diverse flora and fauna. Since the Rio'92 World Summit, the regional governments have been pro-active in creating prestigious national parks and conservation areas on an unparalleled scale. At the same time, however the Basin is inhabited by about 80 million people and its population is growing at 2.4%. This population also contains about 500000 Pygmies, perhaps the largest surviving forest-dependent peoples whose traditional rights to access the forests and their resources need to be respected and protected. In general living conditions in the region are low and the average GDP per capita is estimated at US\$411 a year. Due to poor economic development, education and lack of other opportunities, about 62% of all the people depend on deriving their livelihoods from natural resources generated by the tropical rain forests.

A study was established near the Lobeke National Park (Eastern Province of Cameroon) to qualify, quantify and value various products gathered by the local communities. The results showed that household dependency on forests ranged between 10% to 80% (av. 45%) of the total values of products and services (income) generated by the households. There were six categories of houses build by using various quantities of materials. The 602 houses surveyed in greater detail showed that the villagers used 132189 poles and 36878 thatch components (palm stalks). When multiplied by the regional population dependent on natural resources, the number of harvested young trees and palms escalated to 1.815 billion trees and over 0.5 billion palms. The concentration of plant harvesting near the villages' neighbouring national parks leads to compromised conservation principles, a decline of biodiversity and forest structure. Therefore, it is recommended that alternative and more stable building materials are promoted with special reference to the cultivation of desirable tree species in timber plantations for house construction.

SDEWES.2009.304

## **Spanish Energy Roadmap to 2020: Socio-economic Implications of Renewable Targets**

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### **ABSTRACT**

The European Union has established challenging targets for the renewable energy contribution to be achieved by 2020; for Spain, 20% of the final energy consumption must to come from renewable sources at such time. This objective can be achieved through different energy mixes. The aim of this paper is the analysis of the consequences for the electricity sector (in terms of excess cost of electricity, investment costs, land occupation CO<sub>2</sub> emissions and overcapacity of conventional power) of several possibilities to comply with the desired targets. Scenarios are created from different hypothesis for energy demand, biofuel share in final energy in transport, contribution of renewable for cooling and heating, renewable electric generation (mix generation, deployment rate, learning curves, land availability) and conventional power generation (lifetime of current installations, committed power in next years, fossil fuel costs and cost of CO<sub>2</sub> emissions). Energy demand is calculated assuming different evolutions of the GDP (some of which take into account the current economic climate) and of energy intensity in Spain. The technical potential and the cost of electricity from renewable sources have been estimated in previous, detailed studies by the present authors, using a methodology based on GIS (Geographical Information System) and very high resolution meteorological data. As a result, cost-supply curves are obtained for different hypotheses of change of land usage. Depending on the generating mix, the attainment of the targets will require a land occupation of 10000 to 30000 km<sup>2</sup> and will lead to an increase of electricity costs between 15 to 50% with respect to 2006. As an example of results obtained, the figure shows the renewable share in final energy consumption, the operating and LCA CO<sub>2</sub> emissions of electricity-generating sector, the land occupancy for renewable electric generation, the additional cost of electricity (with respect to 2006) and the investment costs (as a fraction of national Gross Fixed Capital Formation in 2006) for year 2006, and two final-energy-demand scenarios for 2020. As it can be seen, a lower energy demand reduces considerably the required investment, occupancy and additional cost of electricity to achieve the 20% target.

SDEWES.2009.401

## **The Importance of Energy Planning on The Local Level**

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### **ABSTRACT**

Sustainable development is one of the fundamental goals that we should all have in our minds as a first priority. When speaking about the energy sector it is necessary to disconnect the link between economic growth, resource use and waste production to ensure the basis for energy sustainability. To achieve energy sustainability we can act at different levels, one of them is also the local level.

The main topic of the article will be local energy planning as a tool to achieve energy sustainability. Local energy planning is becoming increasingly topical theme and also a theme which actually needs more and more attention and actual implementation. It seems that some general national measures are no more efficient. Strictly oriented measures, which can be carried out at the local level, are at the growing importance.

I will show the results of the analysis, which I have made with the multiple regression model. With the double logarithmic function I was testing the following hypothesis:

- Local communities that are performing local energy planning are more active at implementing activities than local communities, where local energy planning is not the part of their development strategy.
- Local communities, which have the local energy manager, are more active at implementing activities than local communities without the local energy manager.
- The biggest obstacle when making decisions about investments is the lack of financial sources on the local level.

The results are interesting and at the most interesting is that the financial sources at the local level, despite the contrary expectation, are not the factor with any importance in this story.

I will show the model, present the method and I will also show the results of the analysis. The results will confirm the fact that the local energy planning is important and that the results which can be achieved are enviable.

The most important part of the article will be presentation of the analysis mentioned above. Beside this I will also present answers to the following questions: Why energy planning?, Why local energy planning?, Why long-term planning? and Which are the most important tools for efficient local energy planning?. There will also be presented different key roles of local communities, which have to be taken over to achieve success on the long term.

SDEWES.2009.547

## **Rural Tourism, a Sustainable Alternative**

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### **ABSTRACT**

In the current context of a global crisis, rural tourism houses and businesses are still experiencing the trend of the good economic times. This situation shows that there is a small light from sustainable reference.

In this paper we present socio-economic and environmental theoretical and practical keys which explain rural tourism development in Spanish Pyrenees, considered as a singular tourist destination in Spain.

This study takes part of a wider research that aims to diagnose the state of tourism in Aragon (Spain), and, thus, draw up a list of proposals for improving it inside the sustainable development paradigm, following the main triple bottom line: social, economic and environmental (Elkington 1994).

Creative leisure development within rural tourism and its potential are objectives which provide an alternative to mass sun and sand, or skiing, tourism. As a result of achieving the above objectives, and remembering that our proposal centres on what is called integral and sustainable tourism, in that we start by conceiving tourism based on the new economic situation brought about by globalisation, where micro business, its human resources, services and products must be continually recycled to keep up to date with the expectations of potential customer and remain competitive in a market which has a wide variety of products on offer.

Our proposals are directed straight at developing this sector and all of its alternatives in Spanish Pyrenees under the SD paradigm.

SDEWES.2009.095

## **Alternative Future: Implications of Non-petroleum Energy for An Oil-based World**

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### **ABSTRACT**

An assortment of governmental, technological, environmental, and economic factors have combined to spur renewed interest in alternatives to petroleum for energy. While a consensus on the viability of any of the various technologies is lacking, many governments and corporations alike have vigorous, ongoing research programs. With the election of Barak Obama as the new President of the United States, there is a new sense of possibility in the energy market, not just in America but also across the globe. The result is that the world may stand on the verge of giving up its more than century-old addiction to petroleum for its energy needs. A transition from oil to one or more alternatives would alter familiar global economic and political structures in profound ways. The ramifications will influence developed and developing nations, oil importers and exporters alike. New alliances among governments, corporations, and other groups may challenge existing notions of governance. Although a non-oil economy may be decades away, the vision for it requires near- and mid-term thinking to manage the transition smoothly. President Obama may be in a unique position to catalyze not only the drive away from oil but also the global planning necessary to accomplish it successfully. It remains to be seen if he can capitalize on the hopes he inspired during his campaign and bring solutions that deal with the multi-faceted issues associated with a conversion from oil. This paper uses hydrogen power as an example to explore those issues. However, it will be clear that any change from the current oil economy will entail dramatic changes to the global status quo that must be planned for now.



## Combined Cycle and Cogeneration Heat and Power Systems I

SDEWES.2009.057

### The Impact of Variable Demand Upon the Performance of a CCGT Power Plant

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#### ABSTRACT

Electricity is one of the most essential utilities and demand for electricity is likely to grow with the increase in world population and further developments in growth and infrastructure. For the foreseeable future use of fossil fuel will continue to be the dominant mode of power generation. In this regard gas fired combined cycle technology has become very popular due to its environmental and economic benefits. In a network electrical power is produced many types of power stations and other generating sources. The overall demand for electrical power varies continually (by time of day, by day of the week and by the seasons of the year). The power supply must be continuously adjusted to match the demand. This requires the modulation of the generating stations. Increasing amounts of renewable energy are also being employed to produce this power. The principle sources of this energy comes from either the wind and wave energy (variable and unpredictable) or tidal power (predictable but variable in time of availability and quantity). This variability on the supply side adds increased complexity to the balancing of supply which must be provided by the power generators on the system who are able to continuously modulate their output. Much of this duty will fall upon the available Combined Cycle Gas Turbine (CCGT) plants.

This paper attempts to measure the impact of variable demand on a modern 800 MW CCGT plant. The results of contrasting the performance of the plant when operating under optimum conditions with those measured when modulating the output to match dispatch instructions is presented and compared. These contrasts include the impact of step changes, continual modulation and both hot and cold starts of the plant. The results indicate the changes in fuel used per MWh, CO<sub>2</sub> emitted per MWh and the NO<sub>x</sub> emissions under different operating modes.

From the subsequent analysis significant increases were recorded in both fuel used and CO<sub>2</sub> emitted when the plant departs from optimum operating conditions.

SDEWES.2009.115

## **The Exergy Analysis of Orc Power Station Supplied with Waste Heat from Fuel Cells**

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### **ABSTRACT**

The production of electric energy based on fuel cells is connected with emission of considerable quantities of waste heat. In case of high-temperature fuel cells, this kind of waste heat can be used to production of electric energy in energy technologies like: Fuel Cell - Gas Turbine Hybride - Power Plant.

The waste heat from low-temperature fuel cells at present is used only to heating aims as well as the preparation of warm usable water. At this time there is a shortage of examples in scientific literature, describing technical utilization this kind of waste heat to production electric energy in power station of ORC type. It is the reason of undertaking by authors of proposed scientific article this subject matter and presenting of her in agenda of this year's 5. SEDWES conference.

By the evaluation of the thermodynamic efficiency for this kind of energy technologies - using on the power supply sides the heat sources with low or middle enthalpy - it is also indispensable use the exergy calculation, except calculation of balance of mass and the energy. This permits to regard requirements of the second law of thermodynamics, both in reference to direction and qualities of energy transformations realized in individual aggregates this kind of installation . The same in proposed scientific article be introduced become:

- the concept of ORC power station supplied with waste heat from low-temperature fuel cells,
- the most important assumptions and mathematical dependences for realized exergetic analysis ,
- selected computational examples illustrating the influence of waste heat temperature, the temperature of ambient as well as the kind of organic working fluid on thermodynamic efficiency of abovementioned type of ORC power station.

SDEWES.2009.284

## **Selection and Sizing Procedure of Polygeneration Plants Based on Gas Natural Technologies and Renewable Energy Using Mathematical Programming**

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### **ABSTRACT**

In this paper a systematic procedure to select and size a polygeneration plant based on natural gas technologies and solar energy and biomass gasification as renewable sources is presented. The proposed procedure is based on the concepts of chemical synthesis processes and particularly on the superstructure definition, which contains the possible configurations that can be considered candidates to integrate a polygeneration plant that produces simultaneously electricity, heat, cold and fresh water. Based on that superstructure, a mathematical programming model is developed and applied to an specific case study (Spanish hotel). Three key aspects are evaluated in the mathematical programming problem: energy savings, greenhouse gases emission reductions (GHG) and economic feasibility. The results show, firstly, that the simultaneous production of electricity, heat, cold and fresh water is possible upon the established assumptions. Second, higher economic profitability is achieved with natural gas based technologies but lower energy savings and GHG emission reduction are obtained, through the inclusion of renewable sources it is originated the opposite effect.

SDEWES.2009.378

## **Organic Rankine Cycle (ORC) in Biomass Applications for Cogenerative Systems in Association with Absorption Chillers**

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### **ABSTRACT**

The ORC technology in cogenerative systems has by now reached a level of full maturity in biomass applications. In Europe, there are over 80 plants in operation with a size between 0.2 and 2.2 MW electric, mainly cogenerative systems. The growing request for cooling in civil applications open has opened new possibilities to associate ORC modules with absorbing chillers.

Conventional cooling plants with electric compressors have better COP than absorbing chillers, but they need precious electric energy to operate. Cooling plants with absorbing chillers, instead, can be fed by thermal energy coming from cogenerative plants, with low costs of production and benefits in terms of global energy balance and CO<sub>2</sub> emission savings.

In this study, we compare the economic results, in terms of energy balance and investment returns, in a biomass case study application with ORC modules sized up to 2 MW electric, in case thermal energy is produced only for heating or for both heating and cooling.

Object of the study is to quantify the required value of the produced electricity depending on the main technical and economic variables such as biomass cost, value of the heat and cooling supplied to end users and available heat load in order to reach good feasibility. The analysis will be executed according to the discounted cash flow method and evaluated in terms of discounted economic payback time and net actual value of the investment with target values as required in order to obtain bank financing for such projects. A complete economic feasibility study is performed taking into account market costs for the ORC and the additional required equipment.

The environmental benefits due to CO<sub>2</sub> reduction depending on the electricity generation capacity in different actual scenarios are also evaluated.

SDEWES.2009.533

## **Technical and Economic Potential of Small and Micro-cogeneration Systems in Residential and Tertiary Sector in Croatia**

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### **ABSTRACT**

The yearly consumption of energy for space heating and hot water preparation in the residential and tertiary sectors in Croatia is approximately 70 PJ, whereof the energy produced in public cogeneration plants and public heating plants account for not more than 10%, whereas the rest is mostly covered by combustion of the natural and liquefied gas, diesel oil and fuel oil, wood and lignite. Since only a lesser part of space heating and hot water preparation requirements is covered by generation in cogeneration plants, the residential and tertiary sectors represent potentially the biggest domain for implementation of cogeneration technology in Croatia, which, depending on economic justifiability, could be realized either in the existing or newly built district heating systems or by installation of autonomous micro and small cogeneration units in detached buildings. This paper focuses on technical and economic potential of small and micro cogeneration technologies suitable for operation in specific conditions imposed by heating and cooling demand of typical customers in residential and tertiary sectors.

## Measurement and Monitoring for Sustainability I

SDEWES.2009.122

### Gas-discharge Visualization (GDV) Method In Diagnostics of The Functional Condition

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#### ABSTRACT

The effect of Kirlian consists in the following: round the object placed in special system of electrodes, creating high tension electric field, there is the gas category which luminescence can be seen and photographed. Heterogeneity of electric properties of object, elektronno-issue characteristics, gas evolution, a power exchange with environment - all these parametres of investigated object under certain conditions are shown in photos. And for difficult object not always it is possible to divide influence of this or that factor, that is the method allows to reveal complex reaction of an organism to this or that influence. In university laboratory experiment on measurement of a luminescence at more than 40 persons of a different sex, age and a social status has been made. All received pictures have been classified depending on amplitude, intensity of a luminescence, distribution of beams, etc. On 3 types. Each type includes 3 subtypes.

I type - "normal": it is visually possible to define separate areas or their groups and intervals between them, intensity of a luminescence - average density, average amplitude of beams (from 1.5 to 3 mm), distribution uniform. II type - "asymmetric": non-uniformly distributed areas (Variability amplitudes and frequencies), average amplitude and with sites of defects. III type - "power": high density of distribution of areas without visible intervals, high amplitude of areas, rather uniform distribution. The facts of changes of types electrogramme are elicited at change of a functional condition of examinees. For example, at an induction of a condition of a relaxation transition from II to III type is observed, and at a psychoemotional pressure from III to II type. These facts prove to be true the data researches by means of a framework. Thus the method of gas-discharge visualization (GRV) can be used for diagnostics of a functional condition of the person.

SDEWES.2009.653

## **Detection of The Underground Object by a Triangular Radar System**

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### **ABSTRACT**

The position of the underground object can be determined by three non-colinear radars on the ground. This presentation is a theoretical study of the subject. The input parameters for the calculation of the object position are the coordinates of the three radars and the three times needed for the radar pulses to be reflected from the object and come back to the detectors. Here it is assumed that the positions of the signal transmitters and detectors are the same (compared to the distance to the object). The corresponding equations are given, and they indicate that the appropriate positions of the radars form an equilateral triangle. Furthermore, in order to diminish the error in the calculation of the object coordinates due to the uncertainty of detected times and/or the speed of the radar waves, the horizontal position of the object should be approximately in the radar triangle's centre of gravity. This means that when the approximate position of the object is detected, the position of the radars may be adapted to improve the resolution in the object's position in the next step. We also discuss the problem of uncertain mean dielectric constant of the medium (earth, rock, etc.) between the radars and the object, which in turn determines the wave velocity of the radar signal. Since the horn antennas with directed signals are used in the corresponding experimental research, there may be two independent and more or less reliable methods for the determination of the dielectric constant of the medium and the object: either using the intensity of the reflected wave in the case of perpendicular reflection, or the angles in the Fresnel's refraction law. The latter method seems to be advantageous for the determination of the medium dielectric constant since the incident and the refraction angle with respect to the air/ground interface are given by the antenna direction and indirectly by the object position. This method can be applied in various environmental applications such as in search for underground water or gas pipelines, leakages in such pipelines or in search of different underground pollutants and other dangerous objects.

SDEWES.2009.670

## **Detection of Discarded Household Hazardous Waste in The Ground with Ground-penetrating Radar Method**

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### **ABSTRACT**

Hazardous materials are found in almost every home. The products, such as paints, cleaners, oils, batteries, and pesticides, contain potentially hazardous ingredients and require special care when we dispose of them. Household products that contain corrosive, toxic, ignitable, or reactive ingredients are considered to be household hazardous waste. Improperly discarded household hazardous waste can pollute the environment and pose a threat to human health. In our research we study if it is possible to detect such objects using ground-penetrating radar (GPR), which is becoming increasingly important for solving many environmental problems. GPR is a geophysical method that can provide high resolution three-dimensional images of subsurface structures or buried objects. We used spent batteries as test material, which represents potentially hazardous object. The results of this study show that the GPR technique with 1.6 GHz antenna can detect household hazardous waste buried in the soil.



SDEWES.2009.659

## **Application of Ground-penetrating Radar to Detection of Different Material Objects**

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### **ABSTRACT**

Ground-Penetrating Radar (GPR) is a non-destructive sensing tool which uses high frequency electromagnetic waves to acquire subsurface information. This non-destructive method of subsurface analysis is becoming increasingly important for solving many environmental problems. The GPR antenna with frequency 1.6 GHz was used in this research. We measured objects made of different materials like metal, plastic and glass in the air inside cardboard box. We also present results of a study of GPR technique in water. We measured the reflected electromagnetic waves from different objects in shallow water. The test materials served as model systems for different potentially dangerous objects, because they have different dielectric constants. GPR responds to changes in dielectric constant of different materials. The robust data processing method was used to present reflections from different materials. The results of this study show that the GPR technique with 1.6 GHz antenna can detect and distinguish between different materials studied at room temperature. The obtained results also indicate that GPR 1.6 GHz antenna is effective in detecting objects in water near its surface. We have thus demonstrated that GPR can be a useful remote sensing technique for the non-destructive detection of potential environmental risks either hidden above ground or close to the surface and under water.

SDEWES.2009.169

## **Application of Ground Penetrating Radar for Environmental Remediation**

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### **ABSTRACT**

Ground Penetrating Radar (GPR) is an excellent tool to detect various types of underground objects. It can for example be used to detect water leakages in communal water distribution system.

A new algorithm for numerical iterative solution of Maxwell equations has been tested on the example of environmental remediation of the upper Soča-valley frontline from World War I at the Kolovrat hill. This hill was a battlefield of the decisive battle during the last Soča offensive in 1917, when German troops under the command of Lieutenant Erwin Rommel captured Kolovrat back from Italians and started a series of events that led to a collapse of Italian frontline. Today the Kobarid museum in cooperation with the Walks of Peace in the Soča Region Foundation established an outdoor museum of the Soča frontline.

The Kolovrat hill was measured by GPR in order to find the underground metallic remnants from the war, such as pieces of grenades. The obtained images demonstrate that GPR is an excellent method for detection of metallic underground objects. In addition to the detection of their presence it was possible to determine their exact location, which is useful information for environmental remediation of the former battlefield.

## Sustainable Manufacturing and Mining II

SDEWES.2009.431

### Energy and Water Conservation Potentials in The Brazilian Iron and Steel Industry

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#### ABSTRACT

The iron and steel industry is the second largest energy consumer among the energy-intensive branches of the Brazilian industry. Although it is a modern, competitive industry, with substantial exports of both iron and steel, large conservation potentials exist for energy and water usages countrywide.

Energy conservation potentials are calculated in this paper for integrated and semi-integrated steel mills, and also for the plants which produce pig iron consuming char coal, for the semi-integrated steel mills, or for exports. Such calculations are carried out comparing the actual energy consumption with what could be achieved with the use of the best manufacturing technologies and practices available in the market (best practices), for each main stage of the production chain.

Both heat and electricity conservation potentials are presented, considering the best practices in Brazil and worldwide.

The water conservation potentials were calculated just for the integrated steel mills and some semi-integrated plants and taking into account best practices available in the country.

Indications are given in the paper about the technologies that constitute the best practices considered in the calculations and recommendations are put forward for new public policies and the corresponding energy conservation programmes which could help the Brazilian iron and steel industry to gradually approach such practices.

The energy conservation potentials results presented in this paper were demanded to the Interdisciplinary Centre for Energy Planning, State University of Campinas, by the Confederation of the Brazilian Industry, within a project financed by the National Programme for Electricity Conservation (Procel).

SDEWES.2009.462

## **Exploitation of WEEE for The Production of Metal Powder**

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### **ABSTRACT**

Due to the rapid technological progress, the replacement of electronic equipment is very often necessary, leading to huge amounts that end up as waste. In addition, waste electrical and electronic equipment (WEEE) contains metals of high commercial value and others that are supposed to be hazardous for the environment. Consequently, WEEE could be considered as a significant source for recovery of non-ferrous metals. Among these waste, computers appear to be distinctive, as far as further exploitation is concerned. The present study aims to develop a hydrometallurgical process in order to produce Cu, Zn and Ni powders, appropriate for powder metallurgical applications. Printed circuit boards (PCB) were used as a raw material and firstly the dissolution of waste in acid media was studied. A thermal pretreatment was carried out for the separation of the non metallic parts and further characterization of the solid residue by XRD, XRF and SEM. The homogeneity of the resulted samples was investigated, through a series of experiments. The investigation of the factors reflecting to dissolution included the concentration (0.5 M to 6 M) of the solvents (HCl, HNO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub>), the temperature, the reaction time and leaching efficiency of metals.

SDEWES.2009.526

## **Material Efficiency of Biofuel and Chemical Processing**

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### **ABSTRACT**

Biofuels such as Fischer-Tropsch diesel, methanol, DME, ethanol, butanol and chemicals such as ethylene etc. obtained from biomass have raised much interest in processing industry because the potential to replace fossil fuels and reduce greenhouse gas emissions.

The sustainable utilization of biomass should find routes that retain the maximum amount of material and energy content of feedstocks in the products. Transferring much of the original energy content of the feedstock into the product is important especially in fuel production. If much energy content of the raw material is liberated, even recovered as heat as heat energy in the production process, it is of less value than the energy in the liquid biofuel products. On the other hand further upgrading can increase value of the components even they may lose some of their material and energy content.

Even it is of fundamental importance, the material and energy efficiency of the products obtained from different raw materials by various routes has not been received attention it deserves. The material efficiency and heat content of the products can be seen as a step in optimization of biomass utilization.

In this paper material efficiencies and heat contents of the biofuels and chemicals from various raw materials are systematically studied. The efficiencies of different chemical routes are reported.

Results of material efficiencies and heat content can be used for finding potential routes which can then be analyzed more rigorously by including production costs.

SDEWES.2009.293

## **New Glass Cullet Beneficiation Process for Improving Glass Container Plants Energy Efficiency and Reducing Their Green House Gases Emissions (CO<sub>2</sub>)**

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### **ABSTRACT**

New glass cullet beneficiation process for improving glass container plants energy efficiency and reducing their green house gases emissions (CO<sub>2</sub>)

The paper describes a new glass cullet beneficiation process and proves the important economic and significant environmental benefits that the glass container industry can achieve with its application.

The main achievable advantages are the following:

Regarding the glass cullet beneficiation process:

Improve, significantly, the quality of furnace-ready cullet processed from bottle-bank collection systems by decreasing both the amount of hard to melt impurities (ceramics, porcelain, stones and so on) and the amount of water soluble organic substances.

Decrease the amount of waste produced by cullet processing plants from the current 20 - 25% to less than 2% by transforming it into recyclable and very useful new raw materials for hollow glass, ceramic, bricks and concrete productions.

Regarding the glass container process:

- Reduce the hollow glass furnaces specific energy consumptions by using higher cullet percentages by recycling this previously waste product.
- Improve the heat exchange efficiency by reducing the organic substances present and thus the tendency to form persistent foam on the melt surface,
- Make it easier to control those oxidation-reduction reactions from which the glass stability depends and, in so doing, improve the most critical forming phases controls (glass conditioning and cooling in the moulds).
- Obtaining a faster refining process.
- Regarding the glass container production efficiency:
- Reduce the defective bottles due to a significant quality improvement of furnace-ready cullet; to day, this cullet has, on average, 60 g/ton of non fusible materials.
- Improve the pulled glass chemical homogeneity leading to a easier forming process control.
- Regarding the environmental impact:
- Give an important contribution to reduce green-house gas emissions (CO<sub>2</sub>).

- Minimize the glass waste land-filing.
- Total recycling of industrial water.

The possibility to recycle the primary cullet process rejects will allow, at the same level of hollow glass production, to reduce the consumption of natural raw materials (in Italy around 280.000 ton/year), and therefore, taking into account the average yield of the beneficiation plants, to reduce mineral extraction by about 330.000 ton/year.

## Nuclear Power

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SDEWES.2009.705

### **Sustainable Nuclear Energy Dilemma**

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#### **ABSTRACT**

Sustainable energy development implies the need for the emerging potential energy sources which are not producing adverse effect to the environment. In this respect nuclear energy has gained the complimentary favor to be considered as the potential energy source without degradation of the environment.

The sustainability evaluation of the nuclear energy systems has required the special attention to the criteria for the assessment of nuclear energy system before we can make firm justification of the sustainability of nuclear energy systems.

In order to demonstrate the sustainability assessment of nuclear energy system this exercise has been devoted to the potential options of nuclear energy development, namely: short term option, medium term option, long term option and classical thermal system option. Criteria with following indicators are introduced in this analysis: nuclear indicator, economic indicator, environment indicator, social indicator... The Sustainability Index is used as the merit for the priority assessment among options under consideration.



SDEWES.2009.418

## **A Technical Approach to The Low Carbon Society Based on The New Nuclear Power Utilizing Thorium**

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### **ABSTRACT**

The advance of the global warming requires us the construction of the sustainable society. The one form of sustainable society is called low carbon society. The concept is to achieve sustainability by reducing emission of CO<sub>2</sub> from primary energies such as power plants, transportation, which mainly uses fossil fuel. For this realization, the decarbonization of the primary energy is necessary. Nuclear power is getting reconsidered. However, nuclear power occupies only around 6% of the primary energy. This is because that present nuclear power has concerns on safety, radioactive waste and the nuclear proliferation. These concerns can mostly be solved by using thorium as an alternative nuclear fuel.

Thorium has been examined in many countries including U.S.A. for more than 50 years. The molten-salt reactor experiment successfully was operated in 60's at ORNL in U.S.A. However, thorium utilization was not selected due to the influence of the Cold War. After the end of the Cold War, thorium is becoming to be discussed again. Molten-salt reactor became a candidate of generation IV reactors.

Developing countries, China and India, have important roles for constructing low carbon society. Technical approaches for low carbon society should be designed to be accepted by these developing countries. Both China and India are going to build more nuclear power plants but they have little uranium. On the other hand, they have abundant thorium. India is promoting the thorium use for many years. China has begun to examine the thorium use. Brazil and Turkey also have a lot of thorium.

It is also important for constructing the low carbon society to reduce CO<sub>2</sub> emission from the transportation section. Rare earth is required to improve motor and battery of electric vehicle. Thorium is obtained as the by-product of rare earth. About hundreds of thousands ton is in stock. Thorium utilization will be a suitable primary energy both for developing countries and electric transportation section.

SDEWES.2009.292

## **Preliminary Evaluation of Isolation Systems Influence on The Seismic Loading Effects in a Generation IV Reactor**

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### **ABSTRACT**

This paper deals with a preliminary safety assessment of a next generation nuclear power plant (Generation IV) structures response under a reference design basis earthquake excitation, taking into account also the main isolating device effects.

The GEN IV technology roadmap has identified the six most promising advanced reactor systems for future deployment, among which the Lead-Cooled Fast Reactor, with molten lead as the reference coolant and lead-bismuth eutectic as backup option. Therefore the aim of the proposed study is to analyze the seismic related structural effects and provide some contribution in term of the evaluation of the structural vulnerability (of the designed structures) for the development of the European Lead-cooled System (ELSY) international project.

In fact, the safety aspects related to the postulated accident scenario, characterized by the seismic waves propagation from the ground to the reactor internal structures, must be considered as a consequence of the choice of a large liquid metal mass as primary coolant. Moreover a great attention shall be focused on the evaluation of the hydrodynamic forces and the coupling effects between fluid and structures, induced particularly by Safe Shutdown Earthquake loadings, that should accelerate the contained coolant, with and within the reactor vessel, and result in waves impact that may impair the structures capability to withstand, without structural damages, the related dynamic loads.

In order to increase the reactor safety it is assumed to adopt seismic isolators under the foundation. The isolators demonstrated to be able to attain a strong reduction in the accelerations propagated to the reactor vessel structures (coupled to large rigid-body displacements, which must be limited by means of dissipating elements) leading to significant increases of the structural system resistance.

Finally, a numerical assessment was carried out for not isolated and isolated foundation cases, making use of suitable finite element models of the reactor vessel and its main internal structures, implemented with appropriate dynamic codes. The critical analysis of the obtained numerical results, for the two considered foundation cases, and their following comparison is focused to investigate the consequence of the seismically induced metal coolant free oscillations (sloshing waves) and to highlight the isolators efficiency, with the intent also to contribute to the safety optimization of the mentioned systems.

SDEWES.2009.297

## **Spent Fuel Transport Cask Thermal Evaluation Under Accident Conditions**

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### **ABSTRACT**

The casks used for transport of nuclear materials, especially the spent fuel element (SPE), are designed according to rigorous acceptance criteria in order to provide protection to people and environment against radiation exposure particularly in a severe accident scenario.

Standards requirements cover both normal transport condition and accidents scenario such as impact and rigorous fire events. International Atomic Energy Agency (IAEA) cask transport packaging test requirements include a 9 m drop onto a flat unyielding surface and subsequent full exposure to an engulfing fire for 30 minutes (fire test) or to an environment at 800°C temperature for a numerical simulation or for a furnace test.

The thermal behaviour and the temperatures distribution of a PWR spent fuel transport cask, like that designed in Italy by AGN and certified in the 80's, were analysed both in normal and accident conditions according to the IAEA accident test requirements.

Using ANSYS finite element code, a series of thermal analyses were carried out in order to obtain the maximum fuel temperature and the temperatures field in the body of the cask both in normal and in accidents scenario. The aim of this paper was to characterize the relevant heat transfer mechanisms between the SPEs and the external environment (fire in the test or air in the normal conditions).

In the analyses all the heat transfer modes between the cask and the environment and inside the cask itself were taken into account. Moreover both wet and dry fuel storage inside the cavity of the body were analyzed. In order to follow the standards requirements, thermal analyses in accidents scenarios were performed adopting a deformed shape of the shock absorbers to simulate the mechanical effects of a previous IAEA 9 m drop test event. Impact tests on scale models of the shock absorbers were already carried out in the past at the University of Pisa.

Steady-state thermal and transient analyses were performed adopting respectively a not deformed and deformed shapes of the shock absorbers in order to evaluate the effects of normal and accident transport conditions. Finally other transient analyses were performed to simulate the cooling down conditions of the cask after the fire event for a time long enough to achieve the steady-state condition again.

In the paper the results of these analyses, used for the new licensing approval by the Italian competent Authority of the cask for PWR spent fuel transport, are discussed.

SDEWES.2009.018

## **Risk and Opportunity Management for Sustainable Development Through Construction Nuclear Power Plants in The Gulf Countries**

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### **ABSTRACT**

The countries of the Gulf region have the capacity to rapidly expand their sustainable development because of their economic growth and gross domestic product (GDP). Furthermore, energy demands will be increased enormously as compared with present need levels. However, their sustainable development needs an energy resource which must be economical, environmentally sound and socially sustainable. For sustainable energy needs in the region, Construction of nuclear power plants can be an alternative. However, construction of nuclear power plants provides opportunity and risks. There are vast theories, strategies and tools which can decrease the risks from nuclear energy and increase opportunities. Using nuclear energy increases safety, decreases green house emissions and protects the environment. However, this paper chiefly provides a discussion of new risk and opportunity management methodologies. The new risk management methodology helps to illuminate the consequences of risks in a nuclear power plant environment which might otherwise affect public health and safety. Furthermore, risk management can play a role in highlighting the consequences and the effects of the risk. In addition, new opportunity management helps people to understand the potential opportunity implicit in nuclear energy. Besides, new risk and opportunity assist management and other stake holders to rate priorities for the risks and opportunity and determine risk and opportunity levels. The new risk and opportunity management approach provides data, information, tools and strategies, which are potentially more appropriate for evaluating the risk and opportunity from economical, social and environmental perspective in the Gulf countries. In addition, the new risk and opportunity management methodology develops action plans that determine and implement the most appropriate tools for managing those risks and any opportunity. The risk and opportunity management methodology provides appropriate data and information to analyse them to formulate strategies. Furthermore, it helps to build proper design, high quality construction and safe operation. The new risk and opportunity management methodology provides tools to monitor strategies, design, construction, and operation in nuclear energy. This paper assists to decrease risks to protect human health, the environment and beyond national borders and future generation. It increases opportunity growth economic and sustainable development through constructing nuclear power plants in the Gulf countries.

## Approaches to Sustainable Water Development: Methodologies

SDEWES.2009.211

### Perspectives in Integrated Water Resources Management; a Methodology to Explore Social Acceptance for Water Management Strategies Under Changing Conditions

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#### ABSTRACT

Water management faces major challenges to cope with potential global impacts, and the inherent future uncertainties in both the water system as well as the social system in a sustainable way. Uncertainties in our water system relate to (changes in) drivers and pressures and their effects on the state, like the effects of climate change on discharges. Uncertainties in the social world relate to changing perceptions, objectives and demands concerning water (management), which are often related with the aforementioned changes in the physical environment.

The methodology presented here comprises the 'Perspectives method', derived from Cultural Theory, a method on analyzing and classifying social response to social and natural pressures. The methodology will be used for scenario analysis and to identify social responses including changes in perspectives and management strategies. The scenarios and responses will be integrated within a rapid assessment tool to provide users with insight about the interaction of the social and physical system and to identify sustainable water management strategies. We will argue that in order to achieve a sustainable water system, changing social perspectives need to be considered. Subsequently we will show the theoretical and methodological steps to measure, classify and analyze present social responses. Finally we will provide you with the first insights about analyzing future perspectives and the (non) support towards certain water management strategies, and the way it contributes to a more sustainable future for which it is necessary to broaden our idea about keeping our environment safe and livable for

future generations further than the present point of view, and to explore a multitude of scenario's with different perspectives in different contexts.

SDEWES.2009.282

## **Assessment of Environmental Water Cost Through Physical Hydronomics**

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### **ABSTRACT**

The Georgescu-Roegen's statements about the connexion between the Economy and the Thermodynamics, together with the Eco-integrator approach introduced by Naredo after analyzing the water cost definitions given in the European Water Framework Directive (WFD), are the outline backgrounds of the work presented in this paper.

Assuming that the physical laws are called to be the objective and universal tools to assess water costs, Physical Hydronomics (PH) has been developed as the accounting tool for the WFD application. PH is defined as the specific application of the Thermodynamics to physically characterize the degradation and correction of water bodies. While Thermodynamics can be interpreted, in this context, as the Arithmetic framework, Physical Hydronomics can be understood as the prevailing Accounting Principle. The Second Law of Thermodynamics, through the exergy loss calculation, is the basic working tool in this study. The final objective of PH is to use those calculated physical costs as a guide to allocate the environmental and resource costs proposed by the WFD.

In this paper, the general framework and the basic accounting principles of PH are explained. First, from the quantity and quality measurements in the river (they give the exergy value to water bodies), the exergy profiles of the river at different statuses (those defined by the WFD) are obtained. Then, the environmental cost of water is obtained (in energy units) as the exergy needed to cover the gap between the current state of the river and the objective state defined by the applicable legislation to fulfil the European requirements. To do it, the efficiency of water treatment technologies are introduced in the analysis.

To illustrate the application of the PH's methodology, the example of the Spanish Muga Basin, sited in the Inland Basins of Catalonia, is summarized in the last part of this paper. The results show that similar results to conventional Measurements Plans to fulfil the WFD objectives is obtained. However, PH presents an important advantage: costs could be allocated according to the degradation (exergy costs) provoked by the different water users (meeting in this way the WFD's polluter-pay Principle) in water bodies.

SDEWES.2009.475

## **Physical and Chemical Properties of Waste Water from Ready-mixed Concrete Plants**

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### **ABSTRACT**

Every year a substantial amount of ready-mixed concrete produced is returned for disposal, as well as a huge amount of waste water which is used for washing out truck mixer drums at the end of each working day to prevent fresh concrete residue from setting in the drum overnight. Water discharged from ready-mixed concrete plants can pollute local watercourses due to the fact that mixer wash water is classified as hazardous waste by world and European legislation. This paper focuses on the determination of physical and chemical properties of truck wash water according to standard specifications for mixing water in concrete. The aim of the study is to investigate whether Greek waste water from ready-mixed concrete plants is suitable for concrete mixing water and if not, what are the possible alternatives for the utilization of waste water in this field of application.



SDEWES.2009.065

## **Supercritical Water Technologies of Closed-circuit Systems of Life Support**

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### **ABSTRACT**

It was found that supercritical water (SCW:  $T \geq 374^\circ\text{C}$ ,  $P \geq 22.1$  MPa) is an active medium for the partial or complete oxidation of organic substances, including low-grade fuels, into more efficient fuel or reaction mass of electro generating devices. In this context, it is believe that the utilization of sewage sludge under SCW condition has a number of advantages over the above process: a long-term process of water evaporation is excluded; water becomes a nonpolar solvent in a supercritical state; because of this, organic substances become soluble and the rate of chemical reactions with the participation of SCW increase; a low viscosity of SCW facilitates the rapid penetration of the solvent into the pores of solid fuel particles and the extraction of organic substances to cause the separation of organic and mineral sewage sludge components; a low process temperature excludes the formation of  $\text{NO}_x$  and  $\text{SO}_2$ .

The results of investigation of the conversion of sewage sludge in supercritical water (SCW:  $T > 374^\circ\text{C}$ ,  $P > 22.1$  MPa) at  $T \leq 750^\circ\text{C}$  and  $P \leq 30$  MPa will be discussed. The sewage sludge after ten years of holding in sludge drying beds was used as the test material. The weight content of organic substances (OS) in the dry sewage sludge is 28.8% and high heating value is  $\text{HHV} = 16.82$  MJ/kg. It was determined that the total SCW conversion degree of sewage sludge OS is  $\approx 90\%$ . According to mass-spectrometric analysis data,  $\text{CO}_2$ ,  $\text{H}_2$ ,  $\text{CH}_4$ , and  $\text{NH}_3$  were predominant among conversion products at  $T > 500^\circ\text{C}$ . The HHV of conversion combustible products was 23.4-23.7 MJ/kg at  $T = 500$ - $600^\circ\text{C}$ , and at  $T = 625$ ,  $650$  and  $700^\circ\text{C}$  was accordingly received  $\text{HHV} = 33.0$ ,  $40.6$  and  $45.7$  MJ/kg. The kinetic parameters of conversion were determined. The results of this work demonstrated that the conversion of sewage sludge in a flow of SCW allowed us not only to separate organic and mineral components but also to convert solid OS into efficient liquid ( $T \leq 450^\circ\text{C}$ ) and gaseous fuel. At  $T > 600^\circ\text{C}$ , water molecules reacted with carbon and served as an additional source of  $\text{H}_2$ . High rate of OS burning in SCW/ $\text{O}_2$  fluid allows creating the closed life-support systems by heat, electric power and clean water at burning of sewage sludge, household and agricultural wastes in SCW. For example, when  $\text{HHV} = 16.82$  MJ/kg the heating of 5.66 kg of water up to  $500^\circ\text{C}$  at  $P = 30$  MPa and use of SCW/ $\text{CO}_2$  mixture as a reaction mass of power generating devices are provided.

This study was supported by the Russian Foundation for Basic Research (Grants No. 07-03-00698, 09-08-00203, and 09-08-00206) and the Administration of Novosibirsk Region.

SDEWES.2009.229

## **Limited Availability of Water - Main Catalyst of Merger Between Sector-oriented Water Management Plans**

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### **ABSTRACT**

Integrated approach in water management - one of the most important concepts underlying the EU Water Framework Directive (WFD), can sometimes be rather difficult to pursue, particularly in areas where the combination between long tradition of sector-oriented approach and administrative sub-division in spatial units that do not match natural river basin boundaries has evidently created non-sustainable and sometimes too constraining water management setting. Such systems are characterised with very limited capability to provide solutions in normal circumstances, let alone the situations that appear to be a result of constantly decreasing availability of water resources recorded in the last couple of decades.

This paper presents a series of concrete examples (encountered in the westernmost part of the Republic of Croatia, i.e. in the County of Istria) on how simple and apparently convincing considerations can help in triggering off and accelerating the whole decision making chain to react unexpectedly promptly and to give birth to reasonable decisions that wouldn't have been reached without the idea (initially considered to be a blasphemy) to solicitate mergers between traditionally incompatible and sector-oriented water management plans (public water supply, irrigation in agriculture, industrial water supply), competing for the same water resources in the region.

Starting from the real-world examples in Istria, the paper discuss feasibility and sustainability of proposed integrated solutions that are not motivated neither by regulations nor previous plans, but are rather a result of pure coincidence that the task to update several existing plans was assigned to the same independent entity which, as proven by later developments, has devised the plan inherently compatible with disadvantageous economic context that is now stumbling many national economies.

## Combined Cycle and Cogeneration Heat and Power Systems II

SDEWES.2009.108

### **Analyzing a Self - Managed Chp System for Greenhouse Cultivation As a Profitable Way to Reduce CO<sub>2</sub> - Emissions**

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#### ABSTRACT

In order to counter global warming, a transition to a low - carbon economy is needed. On European as well as on a regional scale, commitments are made to reduce carbon dioxide emissions. Combined heat and power (CHP) systems can contribute to reduce the emissions of greenhouse gasses. However, in several countries insufficient use of CHP systems can be observed. Therefore, this research points out the economic and ecological opportunities using two detailed agricultural cases applying a self - managed gas fuelled cogeneration system. CHP systems are well known for their excellent energy efficiency and therefore, the installation of CHP systems can be very interesting for the greenhouse sector, from an economic as well as an ecological point of view. After all, within agriculture, the greenhouse sector is the most energy consuming. In several European countries CHP systems are already widely used in the greenhouse sector but mostly, horticulturists prefer not to exploit the CHP system themselves, ascribable to the high capital cost and the imbalance between their heat and electricity consumption. Due to the recent European liberalization of the energy market, however, glass horticulturists have the opportunity to sell excess electricity to the market and by tailored policy and support measures, regional governments can fill the lack of technical and economic knowledge, causing initial resistance. Our economic analysis shows that a self-managed CHP system is viable and moreover, by exploiting the CHP system himself, the horticulturist pulls the strings. By applying the global emission balance, our analysis shows that installing a CHP results in a carbon dioxide emission reduction. Moreover, because of the utilization of CO<sub>2</sub> for atmosphere enrichment, the actual effect on air quality will be more positive than presented. A local emission balance is established in order to investigate the impact on NO<sub>x</sub> and CO emissions. The results show a small increase in the emission of these gasses when a CHP system is installed, indicating the necessity of a catalytic converter. Although the observed cases show that placing a CHP system is profitable from both an

economic and an ecological point of view, it should be noted that the opportunities and limitations of the application of a self-managed CHP system are case dependent.

SDEWES.2009.248

## **Comparative Analysis Between Centralised and Distributed Cogeneration**

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### **ABSTRACT**

The paper presents a method for the comparison of different cogeneration systems based on economical competitiveness at the end consumer. This involves a detailed modelling of the major components of CHP system, taking into account both economical and technical factors.

Our computer model copes with variation of heat and electricity demands, tariff conditions and costs variations in order to allow a comprehensive analysis of the CHP system state and its competitiveness on heat respectively electricity market.

Results come in a very comprehensive and simple form - the calculation of a limit value for the global efficiency of the analysed solution in order to maintain a financial advantage for the consumers respect to other possible solutions.

The last part of the paper was reserved to a series of case studies, that demonstrate the utility of the proposed method.

SDEWES.2009.249

## **The Analysis of The Operation of Cogeneration Systems At Variable Loads**

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### **ABSTRACT**

Starting from the main technologies used in cogeneration this paper analysis the performances o of cogeneration systems at variable loads. For each cogeneration system there were considered four different operation regimes.

For the gas turbines cogeneration systems there were considered only the open cycles where the heat delivered to the consumers is based on the heat recovered from the flue gasses.

For steam turbines we have considered a group with FIL 150 steam extraction turbine that insures heat for the district heating system used in Craiova, Romania.

The main analysed indicators are:

- the gloal efficiency;
- the power to heat ratio;
- heat and power delivered to the consumers.

The results are presented in a graphical way for an easier interpretation. The results are obtain with a program developed by the authors, shortly presented in the last part of the paper.

SDEWES.2009.266

## **Geographic Evaluation of Trigeneration Systems in The Tertiary Sector. Effect of Climatic and Electricity Supply Conditions**

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### **ABSTRACT**

Nowadays, the development of trigeneration systems is especially important in the buildings' sector, where the thermal loads are imposed by the needs of heating, domestic hot water, and cooling. This indicates a strong seasonal character, since the demands depend totally on local climatic conditions and vary considerably throughout the year. To analyze the influence of geography and of the origin of electricity for buildings on the thermal loads and to determine the optimal design for an energy supply plant from economic and environmental points of view, a medium size hospital was selected. The geographic locations were chosen so as to represent the climatic variety in Spain: Santa Cruz de Tenerife (Canary Islands), Almería (southern Mediterranean coast), Valencia (eastern Mediterranean coast), Lugo (northwestern Spain), and Huesca, Zaragoza, and Teruel (northeastern Spain, from north to south, respectively). The solution of a mixed integer linear programming model determined the optimal configuration of the different energy supply plants as well as the optimal operation modes along an entire year, incorporating the local economic/environmental conditions. From an economic point of view, the optimal configuration for all localities included cogeneration modules. From an environmental point of view, the optimal solution is not as general and is strongly dependent on the origin of the electricity supplied by the grid.

SDEWES.2009.452

## **Micro-CHP ( $\mu$ CHP) in Belgium: An Economic Analysis**

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### **ABSTRACT**

CHP technology provides more energy efficiency and environmental benefits compared to traditional methods with separate production of heat and electricity. Up to now, large CHP units are widely adopted for industrial applications, greenhouses, ... while  $\mu$ CHP in domestic applications is less obvious. Field tests with  $\mu$ CHP technologies are currently being executed in several countries and most heating system manufacturers are developing  $\mu$ CHP units aimed at replacing conventional systems in domestic environments.

In this study, an overview of different  $\mu$ CHP technologies is presented and their potential for domestic application is discussed. Based on this assessment, the characteristics of the Belgian (and more particularly Flemish) built asset base, figures of the Flemish distribution network and the current market of heating systems, the total market potential for  $\mu$ CHP in Flanders is estimated.

Furthermore, a techno-economic model is developed to calculate the economic feasibility of  $\mu$ CHP in domestic dwellings, taking into account technical characteristics, representative heat demand profiles for different houses and economic parameters. The outcome of this analysis is used in combination with the market potential figures to determine total energy savings and CO<sub>2</sub> reduction potential for the Flemish region in Belgium. In addition, a sensitivity analysis is carried out to indicate the importance of several input parameters on the resulting energy savings and economic feasibility.

The outcome of this study indicates the required minimum annual heat demand for the viability and economic feasibility of  $\mu$ CHP in dwellings, the total market potential for  $\mu$ CHP in Flanders on the short term, and the conditions of economic feasibility.



## Sustainable Agriculture

SDEWES.2009.404

### **Energy Efficiency in Long-term Mediterranean Cropping Systems with Different Management Intensities**

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#### ABSTRACT

Evaluation of environmental effects of crop production requires consistent information on the impact and the sustainability of crop production systems. Energy analysis is a meaningful tool for assessing or comparing the impacts from agricultural practices and the efficiency of production systems. Besides, the implementation of the energy use in agriculture has been individuated as an objective in the 'climate action and renewable energy package' for the climate change mitigation adopted by the European Union.

For these reason, the study of different cropping system management can represent a good method to optimise input requirements, yield performance and net energy supply.

The aim of this study is to compare and evaluate, in a long-term field experiment (1993-2005) on a Typic Haplustert plain soil at Enrico Avanzi Interdepartmental Research Centre for Agro-Environmental Research of the University of Pisa, located in the Central Italy, the energy use of a rainfed cropping system cultivated at different management intensities: a conventional system (CS), managed with cultural practices typical of the study area and an integrated (low external input) crop system (LIS) characterised by a significant reduction in agrochemicals and machinery use for a six-year crop rotation that included sugar beet (*Beta vulgaris* L. var. *saccarifera*), durum wheat (*Triticum durum* (Desf.) Husn.), sorghum (*Sorghum vulgare* Pers.), sunflower (*Helianthus annuus* L.), durum wheat and set-aside. The energy balance was carried out by determining energy costs for production and repair of machinery, fertilisers and herbicides and fuel and lubricant oil consumption. Inputs and outputs were converted to energy unit measures using coefficients found in the literature. In addition, we determined the efficiency of the crop energy production (output/input).

The results showed that the crop yield was not significantly affected by the management intensities with an increase about 6%. The net energy yield not showed differences between the treatments with an annual mean value of 137 GJ ha<sup>-1</sup> year<sup>-1</sup>,

while the energy efficiency increased about 33% from CS to LIS. In addition sorghum improved this energy efficiency from 9.4 to 22.1. results suggest that LIS had no negative impact on crop and energy yields with a positive impact on energy saving.

SDEWES.2009.684

## **Integrated Pest Management in Agroforestry: Information Technologies Approach**

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### **ABSTRACT**

Integrated Pest Management (IPM) in agroforestry is one of the big challenges for to the future of the modern agricultural systems. The fast development and introduction of information technologies (IT) creates opportunities to expand, improve and in some cases radically change traditional pest management practices. The role of IPM in promoting the sustainability of agroforestry production systems is based on the premise that implementing its principles is essential to optimizing the sustainability of agricultural systems. For improved IPM strategies and tactics to be deployed, the rapidly increasing computer capacity needs to be used to facilitate technologies and techniques that allow continuous crop management systems based on ecological concepts.

The present paper discusses issues related to the implementation of particular aspects of IT that enable specific or complete solutions in the field of agroforestry pest monitoring and management to be created. It presents practical results from the application of a new approach based on digitizing and analysing data on diseases in crops, methods and technical means for collection of climate and other information on specific habitats, and the application of GIS for the spatial positioning of the studied objects. Based on more than 10 years research at the University of Forestry in Bulgaria, the paper draws conclusions about possibilities for the overall integration of these methods in developing information systems and modules that allow better analysis for the sustainable management of agroforestry plantations.

SDEWES.2009.626

## **Studies on Bamboo for Sustainable and Advanced Utilization**

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### **ABSTRACT**

Recently, not only wood but also bamboo utilization has been increasingly needed, as bamboo has advantageous properties in terms of sustainability and fast circulation of resources. However, few investigations from the viewpoint of plastic working of bamboo have been found.

In practical plastic working of bamboo, there are traditional techniques by skilled craftsman to straighten bamboo by loading with heating and cooling. Although they are empirical technique, it can be considered that the working processes have important implications.

In this study, to obtain fundamental knowledge about the plastic working of bamboo, we first investigated thermal-softening properties and residual deflection appearing after heating and cooling processes in imitation of straightening work by craftsman, and the results were as follows.

1. In the heating process, an obvious decrease in relative relaxation modulus due to thermal-softening of lignin was found at around 60°C. On the other hand, no clear change in the relative relaxation modulus was recognized in the cooling process.
2. After the cooling process, about 65% and 75% of residual set was measured when the specimen was loaded on the epidermis and endodermis side, respectively. Also, residual set depended on the maximum temperature reached in the heating process and the unloaded temperature in the cooling process. From these results, it was deduced that the glass transition of lignin from the rubbery to glassy state is important to fix the deformation.
3. Comparing thermal-softening behavior between bamboo and wood, the relative relaxation modulus of wood steeply decreased at higher temperatures than bamboo. On the other hand, while about 75% of residual set was also found for wood, almost the same as for bamboo, larger recovery of deformation with time was recognized for wood than bamboo.

From these results, it can be considered that implications of working processes by skilled craftsman were partially clarified and the fundamental researches lead to advanced utilization of bamboo.

SDEWES.2009.113

## **Globalgap Standard As One Option of Environmental Policy in Sustainable Agriculture**

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### **ABSTRACT**

Agriculture has large impact on quality environment mainly due to application of fertilizers and pesticides. After Czech agriculture transformation in 1990 the consumption of mineral fertilizers rapid fell down on grounds of cost saving. However since 1994 the fertilizer and pesticide application in the Czech Republic has risen again.

The agriculture is the most significant producer of ammonia as well as. Its share of total ammonia emissions is 95%. The ammonia is substance with environmental impact in view of soil acidification and water eutrofization. In 2007 Czech farms burnt 17770 TJ various types of energy (petrol, gas, electrical energy etc.). In the Czech Republic were seven ecological accidents (from total 181 accidents) on water caused by agriculture.

GLOBALGAP is certificated standard of good agriculture practice. However the standard has created in responding to the demands of consumer, retailers and their global suppliers for ensuring of safety agro-product with respecting worker health, safety and welfare, animal welfare it includes beside ones also requirements to environmental protection. The GLOBALGAP can be used as a basic standard for other quality standard (e.g. ISO 9001, ISO 22000, ISO 14000) or tools of environmental protection (e.g. Cleaner Production) too. Application of sensible methods of farming in frame of the GLOBALGAP standard may significantly support sustainable development. Standard implementation and its using are very easy for all farms. The text presents some results from solved project QG 60148 of Czech Ministry of Agriculture. There is a discussion about using of the certificated standard structure as one option of protection environment in sustainable agriculture in the Czech conditions. There are juxtaposition with Cross - Compliance and Cleaner Production too.

SDEWES.2009.484

## **Difficult Choices, Limited Land: Quantifying Tradeoffs Between Development Goals in The Philippines**

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### **ABSTRACT**

Policymakers in developing nations are facing an unprecedented number of changing conditions and resource interdependencies which they must consider when making decisions. The need for environmental restoration that protects water resources, for renewable energy development, and for agricultural production that meets the needs of the population are articulated by many developing countries. Yet the ability of a country's land base to meet these requirements is not often considered in the light of changing conditions such as sea level rise, population growth and urbanization. In the Philippines, current president Gloria Macapagal-Arroyo used the Medium-Term Development Plan (MTDP) to lay out her goals for accomplishing reforestation, agricultural expansion, and poverty reduction, but these goals were not evaluated in terms of their feasibility given the country's land resources. This study uses spatial modeling to quantify the land requirements of these goals in the face of sea level rise, population growth, and urbanization. Scenarios of 1-and 2-meter sea level rise were considered, as well as high, medium, and low population growth and urbanization rates. I conclude that achieving all of these goals together will likely not be possible, particularly in the event of sea level rise, which may force the displacement of coastal urban populations. The Philippine government and its international partners will need to have a serious discussion about tradeoffs between reforestation, energy production, and agricultural goals as the next Philippine administration takes over in 2010. Spatial modeling is a tool with the potential to inform that discussion.

## Conservation and Demand-Side Management I

SDEWES.2009.349

### **The Baseline in Bottom-up Energy Efficiency and Saving Calculations - a Concept for Its Formalisation and a Discussion on Its Options**

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#### **ABSTRACT**

One of the central variables in bottom-up energy efficiency and saving calculations is the baseline energy consumption. The development of this baseline is a challenging task in the evaluation of energy efficiency measures and may induce serious problems especially if the energy service of the analysed subject has changed throughout the implementation of the energy efficiency measure. In this paper a formalised concept of the development process of the baseline is presented that is flexible enough to deal with several difficulties such as changed levels of the energy services. Furthermore the most applicable options for deriving the necessary variables are discussed.

SDEWES.2009.353

## **Strategic Homogenisation of Energy Efficiency Measures: an Approach to Improve the Efficiency and Reduce the Costs of The Quantification of Energy Savings**

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### **ABSTRACT**

With the ongoing efforts on the European level to promote energy efficiency, the need for the development of harmonised evaluation criteria for energy efficiency measures arises. Such criteria will allow extensive comparisons of the success or failure of the implementation of energy efficiency measures throughout Europe and will support the development of a first-best strategy for the realisation of energy savings targets in Europe. Two fundamental evaluation possibilities exist: bottomup and top-down quantifications of energy savings. Bottom-up calculations give a more detailed view of the impact of energy efficiency measures but are much more costly and time consuming than top-down calculations. In our opinion, this effort can be reduced without losing precision in the savings calculations by the homogenisation of these energy efficiency measures. In this paper, we develop a framework specifying how such a homogenisation could look like.



SDEWES.2009.144

## **Connecting Research to Design: Interactive and Iterative Learning About Energy Demand Side Management**

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### **ABSTRACT**

Learning between researchers and practitioners is important for arriving at new knowledge that is translatable into practice and at the same time endures in science. This paper discusses how this notion has been central in 'Changing Behaviour', a project aimed at a better understanding of why demand side management programmes succeed or fail. Generally, there is a growing tradition of evaluation that encompasses the co-construction of programmes, technology and context. However, most current research and evaluation in this particular area focuses solely on the influence of programme characteristics while discarding contextual factors and transdisciplinary integration.

In 'Changing Behaviour', learning between researchers and practitioners in analyzing this co-construction involved not only a theoretical discussion of relevant literature, but also an inquiry into the (tacit, experiential) knowledge base from various practitioners active in the field of demand side management. This in turn informed the selection and subsequent analysis of twenty case studies (on past demand side management programmes, conducted by researchers in various EU countries) - and thus goes beyond disciplinary boundaries. The multiple case study revealed how particular configurations of context-, actor- and programme-variables have interacted to produce certain outcomes. Findings were discussed with practitioners before being translated in a set of themes/procedures that are relevant for the design of demand side management programmes, addressing issues usually overlooked or neglected. These will be tested and refined with and by the practitioners. Eventually the outcomes of this research-practice project include a conceptual framework - grounded in both theory and practice - that helps us to better understand the dynamics of sociotechnical change involved in demand side management programmes, as well as a context-sensitive toolkit for designing and implementing demand side management programmes.

## Approaches to Sustainable Water Development: Case Studies I

SDEWES.2009.183

### Dew, Fog, Rain As Supplementary Sources of Water in The South-west of Morocco

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#### ABSTRACT

From its geographical position, located close to the Atlantic ocean between arid and semi-arid regions, the area of Mirleft (43 m asl, 29° 35' N, 10° 02' W) is characterized by weak annual rain precipitations (less than 22 days with an annual quantity of order on 100 mm on average). Because of the increasing price of mobilization of conventional water, the use of alternative sources of water (rain, fog, dew) is considered. This study reports one year (May 1, 2007 - April 30, 2008) measurements of dew, fog, rain water and its chemical analysis. Four standard dew condensers of 1m<sup>2</sup> surface whose condensing substrate is a special polyethylene-based film (manufactured by OPUR, 2000) consisted of an innovating material of weak thermal inertia and great emissivity for the IR collected rain, dew and to some extent, fog. A specific net was also used for fog collection. The weather data were collected with a 15 minutes time step. Over the one year period were noted 178 dew events (49% yearly occurrence), 31 rain events (8.5% yearly occurrence) and 7 significant fog events (2% yearly occurrence). The total quantity of collected water was 48.65 mm (rain), 18.85 mm (dew) and 1.41 mm (fog). Then collecting dew increases almost 40% the water yield (for fog it is only 3%).

Concerning the chemical analyses, the mean dew pH average is 7.40 (variation  $\pm$  0.28) and 6.85 (variation  $\pm$  0.21) for rain. The mean conductivity is 727.25  $\mu$ S/cm for dew (variation  $\pm$  678.64) and 316  $\mu$ S/cm for rain (variation  $\pm$  306.07). A significant contribution of non marine origin is found in dew for components like Ca<sup>2+</sup>, K<sup>+</sup>, SO<sub>4</sub><sup>2-</sup> and NO<sub>3</sub><sup>-</sup>). In contrast, Cl<sup>-</sup>, Na<sup>+</sup> and Mg<sup>2+</sup> are of sea origin. In rainwater, only Ca<sup>2+</sup> and NO<sub>3</sub><sup>-</sup> are not influenced by the sea vicinity. One notes a seasonal variation of dew composition, with a higher concentration in elements during the dry season. The mean concentration of ions agrees with the W.H.O. requirements for potable water.

SDEWES.2009.277

## **Institutional Shortcomings of Wastewater Management in Ukraine**

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### **ABSTRACT**

This paper is based on first results of an institutional analysis of the wastewater sector in the city of L'viv in Western Ukraine that has been conducted as part of the project "International Water Research Alliance Saxony" funded by the German Federal Ministry of Education and Research.

The predominant problems the wastewater sector in Ukraine faces are high investments needs to modernise the infrastructure, the need for financial recovery of the sector mainly by introducing cost recovering tariffs and the need for well-defined governance structures as a basis for a reliable operation of the sector (World Bank 2006).

The background of the study is that many projects concerning the restructuring of the wastewater system have already been initiated, but in many cases the knowledge about the institutional surrounding the sector is operating in is missing, but this is an essential factor for the sustainable implementation of new technologies.

The New Institutional Economics (NIE) is the theoretical basis of the case study. The main focus of NIE lies on institutions which are "the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction." (North 1990: 3). Using a framework for institutional analysis the paper aims at identifying the main institutional shortcomings in the wastewater sector in the city of L'viv by analysing different factors that are of importance such as rules and norms, governance structures and the role actors play that are involved.

The findings provide insights in the design and enforcement as well as monitoring of rules and norms and the role different actors play in these processes and at the same time provide insights in the gaps that exist. This analysis will provide a basis to make out possible solutions how to tackle these shortcomings to provide a foundation for effective and sustainable implementation strategies of new technologies.

SDEWES.2009.132

## **A General Water Protection Plan of Lake Onega**

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### **ABSTRACT**

Lake Onega is the second largest lake in Europe after Lake Ladoga. The lake is located in the Karelian Republic, in the Leningradskaya and Vologodskaya regions of the Russian Federation. The area of the lake is 9800 km<sup>2</sup>, its max depth is 127 m and the average depth about 30 m. The main cities situated on the shore of the lake are Petrozavodsk and Kondopoga. The lake is connected to the Baltic Sea via the River Svir, Lake Ladoga and the Neva River.

Russia is not joining the European Union (EU) in the near future. However, there is tendency to adopt the central principles of many EU directives also in Russia. Water Framework Directive (WFD) is a useful directive giving the main guidelines about how to organize water management.

The aim of the project was to make an investigation of the status of Lake Onega, to assess pressures and risks into the lake and make a general plan for water protection to guarantee a good chemical and ecological status of the lake, as expressed on the WFD. One purpose of this project was to transfer Finnish knowledge and results of Finnish investigations concerning the WFD to the area of Lake Onega.

In this study, many different steady-state and dynamic catchment and water quality models were used in assessing the effects of different loading scenarios. While Lake Onega preserves a good status of water as a whole, the problems with pollution and eutrophication exist in Petrozavodsk and Kondopoga Bays where anthropogenic loading is more pronounced.

The excessive phosphorus loading with Petrozavodsk wastewaters should be reduced considerably to prevent further eutrophication of Lake Onega. The existing treatment removes about 55-60% of total phosphorus from Petrozavodsk wastewaters. Modern technology permits to increase this figure up to 95%. In Kondopoga Bay anthropogenic impact is most severe, the pollution is heaviest at the head of the bay throughout the year, where Kondopoga PPM withdraws wastewaters for nearly 80 years (40 years without treatment). To improve environmental conditions in Kondopoga Bay the effectiveness of wastewater treatment process at Kondopoga PPM has to be enhanced and phosphorus loading has to be reduced.

SDEWES.2009.417

## **Assessment and Recommendations to Reduce the Pollution Impact Caused by Hydrocarbon Sector in Semani River**

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### **ABSTRACT**

#### Abstract

In this paper are presented some aspects of assessment and facilitation of scale and type of pollution to the river Semani, as a result of hydrocarbon sector activities in Albania. After assessing the environmental impact and figures presented in this paper, concluded that the oil industry takes first place in terms of impact on the environment compared to the whole industry of the country. This referred, in general, to high levels of polluting discharges in the hydro system that pervades the area of extraction and processing of oil and in particular Semani river, but also referred to the nature of risky pollution elements and high cost of cleaning.

This fact is noted in a study of UNEP (2000), which has set 5 "hottest points" in Albania in terms of environmental pollution, two of them both belongs to the oil industry, oil-bearing fields Patos-Marinez and Oil Deep Refining Plant, Ballshi. Widespread of the oil sources and geographic position of the two existing refineries: Oil Deep Refining Plant, Ballshi and Oil Refining Plant, Fieri, have caused relatively high environmental pollution in those areas (UNEP (ed.) (2000); WB / IFC (ed.) (1995)).

## Advances in Thermal Power, Heat, and Cooling I

SDEWES.2009.114

### Energy - Material Model of Power Technology Life Cycle

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#### ABSTRACT

Nowadays it will be observe continuous increase of electric al power demand, which is connected with increase of electrical equipment in households. Moreover Polish and European Union energy policy and sign the Kioto protocol force on polish power sector decreasing emission of carbon dioxide each year.

From this reason most of European Union countries, included Poland, are facing the problem of taking binding decisions regarding the energy market restructuring, which is connected with modernization most of existing power stations or even building the new one. To take this importance decisions will be necessary the inventory control of used power technologies from the point of them energy efficiency, emission level and incur expenditure quantity: material, energy and fuel.

Based on comparative analyze which take into considerations whole life cycle of new and existing energy technologies it is possible to support choice and decision process followed by consequences that are substantial for next generations. The analysis should take into consideration examination the influence of energy technologies from extraction to final recycling. To make the analysis to be helpful in taking decision considered with, both increasing domestic electric power and reducing negative environmental impact, it should give possibility of comparing different energy technologies.

The aim of this paper is to presented characteristic of mathematical apparatus used in work out an energy-material model of power technology life cycle, which take into consideration both dynamic quantification and indicators analysis. Moreover will be presented selected results of comparison analysis of three power technologies:

- gas-steam power plant;
- nuclear power plant;
- integrated wind power plant.

The analysis will be provide with the assumption of the same installed power with all three type of power plants.

SDEWES.2009.112

## **Model of Economic Analysis of Gas-steam Power Plant Life Cycle**

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### **ABSTRACT**

According to European Union energy policy the main tasks for energy sector are: energy security and elimination of the detrimental for environment solution included reduce of carbon dioxide (CO<sub>2</sub>). From this reason most of European Union countries are facing the problem of taking binding decisions regarding the energy market restructuring and liberalization. Taking this decision will be related to a necessity of modernization most of existing power stations or even replacement of those that are the most obsolete ones.

Moreover in connection with reduction of CO<sub>2</sub> emission limits for polish energy sector in years 2008-2012, and European Union pro-ecology politics and still increasing power requirement, gas-steam power plants could be an alternative for existing coal power plant.

The aim of this paper is to present economic analysis model for power technology, take into consideration all life cycle phases according to methodology of life cycle assessment (LCA).

Shown in article model will be taken as factors as:

- installation building cost;
- fuels cost;
- maintenance cost;
- direct and indirect environmental costs, as: charge for taking economic advantage of environment, buying missing limits of CO<sub>2</sub> emissions;
- revenue from sale.

Moreover in paper will be presented characteristic of used mathematical apparatus, will be calculated internal rate of return (IRR) and net present value (NPV), which allow from one side to define cost-effective of building of exact power technology, and from the other side to define period of invest capital return.

Described model will be based on gas-steam power plant.



SDEWES.2009.099

## **Increasing Energy Efficiency of Thermoelectric Power Plant by Optimizing Maintenance of Steam Condenser**

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### **ABSTRACT**

In the context of major changes taking place in the world, beginning the millennium has brought new approaches in terms of global energy development and orientation to a sustainable energy future. A fundamental priority of the Romanian energy sector in the next period is increasing the energy efficiency of the entire system from producer to consumer.

Improving energy efficiency means, in the case of a thermoelectric power plant, identifying flows of energy that are lost, establishing the most profitable measures to reduce losses and prior estimate of the costs that they imply and the profits that they provide. The common problems of energy loss in a thermoelectric power plant are caused by the fouling in tubes of boiler or steam condenser, and because of this, maintenance of steam condenser is of the great importance for reliable and efficient power generation.

In the paper it is propose a mathematical model to optimize steam condenser maintenance by minimizing the total cost of the equipment it and taking into account the occurrence of fouling on the surface of heat transfer.

Increasing energy prices continued in recent years, increased volatility of energy prices, deregulation of the energy market and last but not least, the recent entry into force of Kyoto Protocol influence energy efficiency of the thermoelectric power plants. Therefore, after optimizing maintenance was done, is studying the influence of electricity price variation on the maintenance of power plant steam condenser. It is presented a scenario of increased prices for the supply of electricity as a result of fuel price increase. This scenario is a very useful tool for investigation future developments and their implications.

SDEWES.2009.162

## **Demonstration Test Plan of Closed Cycle Gas Turbine with Supercritical CO<sub>2</sub> As Working Fluid**

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### **ABSTRACT**

Taking advantages of real gas effect and low critical temperature, a closed cycle gas turbine with super-critical CO<sub>2</sub> as working fluid is a promising candidate for green power. Its scaled test is planned with 10kWe class power output under operating conditions of turbine inlet temperature and pressure of 550 K and 12 MPa respectively. New cycle analysis code and heat exchanger performance analysis code are developed to design critical components to take nonlinear features of thermal properties of CO<sub>2</sub> into consideration. Using this tool components involved in the scaled test are designed. CO<sub>2</sub> cycle can generate electricity with a reasonably high thermal efficiency even from heat at intermediate temperatures ranging 550 K through 800 K. Several MW class capacities may have thermal efficiency higher than that of steam Rankine cycle. Before realizing this cycle into practice, however, there exist several critical design issues to be solved. One of them is a requisite for regenerative heat exchanger with high thermal performance having temperature effectiveness more than 95% together with high mechanical strength to withstand high pressure typically of 20 MPa. For this purpose high performance heat exchanger was newly developed. It is a microchannel heat exchanger (MCHE) featured in a large heat transfer area per unit volume and a high heat transfer coefficient two times larger than that of Dittus Boelter correlation with reasonably small pressure drop. New design software for heat exchanger design is developed to quantify axial conduction effect under thermal property variations in the heat exchanger. Component tests verified it has temperature effectiveness over 95%. Based on this technology, the thermal cycle is optimized and sizing and operating conditions of turbo-machines are studied from the standpoint of manufacturing. As a result, CO<sub>2</sub> mass flow rate is determined to be 1.2kg/s and pressure ratio in the range 1.5~2.5. Results show that appropriate turbo-machine type is centrifugal for compressor and radial for turbine whose outer wheel diameters are 20mm and 32mm respectively. Thermal cycle efficiency is expected to be highest at the rotational speed of 100000 rpm. It is shown 10 kW motor power and 160 kW external heat is required for start up until reaching rated speed without the aid of external torque

SDEWES.2009.188

## **Construction of The Unit 6 of The Šoštanj Thermal Power Plant - Next Step in Direction of Sustainability**

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### **ABSTRACT**

The operation of the Šoštanj Thermal Power Plant (TPP) dates back to year 1956. The plant is compound of five coal fired and two gas units. In the period of construction, all units were characterized as the best available technology on the market. In 1983 the production of electric energy reached its peak, as well as the emission of air pollutants. In the second half of the eighties, the first acute environmental damages were noticed. In the 1987 the management of the Šoštanj Power Plant launched the Environmental recovery programme, which has been practically completed by the year 2000.

In the first sight implementing of sustainable development in the TPP using fossil fuel is controversial. But, quite a number of principles of the sustainable development can be introduced in such plants. The recovery programme pointed out the environmental issue, and the harmful effects of the pollution had been greatly reduced. Emission of majority of pollutants was significantly reduced. Next step of modernization of the TPP and increasing efficiency of a plant was installing of two gas units in 2008. Not only electric power of the plant, also efficiency of the existing Units 4 and 5 enlarged due to using a heat of gas turbines as additional source for heating fed water.

With best available technology in the field of electric energy production the efficiency of the plant amounts as much as 43% in the first decade of the twenty first century. So the decision of the Republic of Slovenia to construct a new unit in Šoštanj is more than right. During the implementation of the recovery programme the main aim was to reduce the emission of sulphur dioxide, nitrogen oxides and dust particles into the atmosphere, as well as reduced water and ground pollution. Furthermore, the construction of the new unit will help reduce the emission of carbon dioxide per unit of the generated electric energy. This will eventually reduce the environmental pollution with other pollutants as well and at the same time increase the economic efficiency and competitive strength of the Šoštanj TPP. Ethical aspect of the sustainable development is of substantial importance as well, striving to preserve the natural resources for the future generations.

SDEWES.2009.314

## **Discontinuation of Individual Boilers Operation in The Function of Sustainable Development**

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### **ABSTRACT**

Even though energy is the basis of existence and economic growth, the time is ripe to pay much more attention to the effects of energy production on the environment. In the time of industrial development, by the half of the previous century, the great population migration occurred and the towns and cities abruptly enlarged and populated. Individual housing heating was designed and constructed independently. Since no particular attention was paid to the level of combustion by-products emission, the most of the buildings had individual boiler rooms, mainly fueled by the fossil fuel (coal or wood).

The goal of this paper is to point at the positive effect of discontinuation of individual heating boilers operation (dispersed energy sources) and connecting them to the district heating system in urban environments in order to improve the energy efficiency and reduce greenhouse gases emission, in the function of sustainable development. The paper presents the comparative analyses of fossil fuel consumption for heating the individual buildings with own boilers, and of the natural gas for the same buildings, in a scenario where they are connected to the district heating system. The environmental effects are a special contribution and they are presented on one hand through the substitution of the fuel, and on the other hand through an optimal operation of the high energy efficiency facilities in comparison to a large number of individual boilers with relatively low efficiency.

## Education and Technology Transfer for Sustainability

SDEWES.2009.098

### **Role of Education in Sustainable Governance of Protected Area - from Global Issues to Particular Challenges of Society in Transition**

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#### **ABSTRACT**

Global challenges we are all facing today, do question our concepts, views and understanding of sustainability and much more - the actions taken to meet that ideal, first defined by environmentalists decades ago. The power that has been given to education for sustainability in international documents, doesn't reflect in national strategies and especially not in the practice of most of the modern societies. While we are celebrating The Decade of Education for Sustainable Development, global consumption and waste of resources doesn't decrease. On the contrary - the evidence shows that major consumption is taking place in the countries with the highest level of development - including the education.

Being affected by all these trends, complex activity of protected area governance requires set of skills and competences that will enable not only managers and staff, but also wide circle of stakeholders, to participate in environmentally, socially and economically responsible decision making and actions. Demands are high and it is especially visible in less developed countries, where requirements far exceed capacities - of the area and actors of its governance. Lack of governmental and institutional support is usually followed by less developed individual capacities of the parties involved.

Being among countries in transition, Serbia is facing many challenges, with protected area governance left aside especially in terms of developing capacities for effective or, hopefully, sustainable solutions and actions. Lack of strategically planned education efforts to improve the situation is one of the obstacles in overcoming the gap between high demands and reality in this area.

This paper offers brief review of the issues present in Serbia as country in transition in terms of protected area governance, in the context of modern understanding of sustainability as well as of global issues that affect our lives on daily basis. It provides frame of research study designed to better understand the role of education on the way to sustainability in protected area governance in Serbia.

SDEWES.2009.461

## **Integrating Ecodesign Through Workshops**

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### **ABSTRACT**

Companies can integrate and work with ecodesign in many ways and a number of tools within ecodesign are available that companies can choose among. This paper is based on a PhD study and it describes how workshops can contribute to the integration of eco-design at the Danish pump manufacturer Grundfos.

As an analytical framework, three overall purposes for integrating ecodesign is proposed: 1) Creating awareness and motivation for the product developers to make them integrate the environment in their daily routines, 2) Creating a social network where the product developers can receive information and education as well as assistance in the organisation, and 3) Provide the product developers with tools which should enable them to consider and handle the environment in the daily work. Based on the three purposes there can be different types of workshops which in different ways provide overview and perspective for eco-design at company level.

During the case-study, two environmental workshops have been held at Grundfos. One workshop was held by the Technical University of Denmark (DTU) and the consultancy company IPU and was a part of a project financed by the Danish Environmental Protection Agency. The other workshop was held as part of the PhD project. The overall purpose with both workshops was to try out ecodesign methods and tools.

By analysing the workshops in relation to the analytical framework, it is concluded that the two workshops mainly provided input to which ecodesign tools the company could use and thereby to the third purpose. The workshops also gave input on how to create awareness and motivation of the product developers which relates to the first purpose. However, the workshops gave only very little input to what a social network should imply to support eco-design and how it could be created.

SDEWES.2009.486

## **E-learning for Environmental Education: Opportunities and Challenges**

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### **ABSTRACT**

The UN Decade on Education on Sustainable Development has contributed to increase the number of training courses, activities and materials related to Environmental Education, and in this context a primary role is played by the process of e-learning.

Even if there are many e-learning courses related to sustainability, only few instruments have been developed to evaluate them. The aim of this study is to review different researches on the use of e-learning and to integrate them with the elements that can define the quality of a process of Environmental Education.

The case study was suggested by the Italian Ministry of Education which proposed an e-learning course as part of the secondary school programme of Environmental Education. This proposal was used to analyse the different opportunities offered by information and communication technologies to Environmental Education and to define a set of guidelines to support educators, teachers and learners in assessing the quality of e-learning proposals on Environmental Education.

SDEWES.2009.374

## **Engineering Education for a Sustainable Future: Competences, Pedagogy and Curriculum**

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### **ABSTRACT**

Introducing sustainable development (SD) in engineering education has been a key topic in many technological universities (Segalas et al., 2004), accreditation agencies (ABET, 2007; CCPE, 2008; ECUK, 2005) and International and National networks of universities.

At the UNESCO chair of Sustainability of the Technical University of Catalonia (UPC) under their PhD program on Sustainability the authors have carried out a research on:

1. What SD competences may engineers have when graduating?
2. How should SD competences be taught/learned at technological universities?
3. Which curriculum structure is more suitable to facilitate the acquisition of SD competences?

To evaluate the competences we compared three leading European universities in introduction of SD. The competences are classified in three categories: knowledge and understanding, skills and abilities and attitudes (Segalas, et al., 2009).

To evaluate the pedagogical approach that facilitates the SD learning we analysed 9 case studies of courses on Sustainability from 5 European technological universities. We used conceptual maps (Novak, 1998; Segalas et al., 2008) as assessment tool.

To analyse the curriculum design for SD 50 experts on curriculum design and teaching SD courses were interviewed.

The methodology and results of this work are presented and recommendations to introduce SD in technological universities in the three fields: competences, pedagogy and curriculum are suggested.



SDEWES.2009.611

## **Educating Engineers For/in Sustainable Development? What We Knew, What We Learned and What We Should Learn**

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### **ABSTRACT**

In 2010 the fifth bi-annual Engineering Education in Sustainable Development Conference will take place in Gothenburg. Before, smaller Environmental Training in Engineering Education conferences took place annually. What questions have been addressed, what answers have been provided and what are the remaining topics for research into Engineering Education in Sustainable Development. A main question concerns the identity of engineering: Is it part of the problem or part of the solution. Unsurprisingly perhaps, we claim its both. To provide more and better solutions engineering education should adapt itself, and open itself to social science driven approaches and active learning in order to make the engineer a valuable SD problem solver. This paper will provide an overview of questions that were recently addressed and answers that were provided and present an agenda for further research in EESD.

SDEWES.2009.499

## **Sustainability Education in UAE Engineering Schools**

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### **ABSTRACT**

Over the last two decades, the United Arab Emirates (UAE) have witnessed an unprecedented boom in the construction industry resulting from large-scale infrastructure projects, speedy urbanization and real estate development. While this construction boom played a major role in converting Dubai, one of the UAE's city states, into a major global hub that links the East and the West, it has been also among the prime resource-intensive sectors that adds to the oil producing sector-the backbone of UAE economy. Consequently, the Global Footprint Network claimed that the UAE is the largest resource user per head in the world. In addition, the WWF, in its 2006 debated report, has named Dubai as the second-highest per capita carbon emissions producer in the world. With such alarming outcomes, 'sustainability' and 'greening' became the buzz words in this region for policy makers, construction and design professionals as well as citizens. Today, numerous sustainability initiatives as well as enforcing legislations are introduced and adopted in impressive ways in UAE such as the Masdar initiative, the world's first zero-carbon, zero-waste development, or the Dynamic Tower. But what is alarming is that the emirates' sustainability initiatives are tied to foreign alternative energy companies, engineers, scientists and entrepreneurs who do not have a long-term interest in the country. The question remains: who is taking ownership of the long-term development and sustainability agenda in the UAE? To build this sense of ownership of the UAE future, the key principle of sustainability, educating the country's future engineers about the concepts of sustainable development should become the foremost prerequisite on the sustainability agenda. UAE with its innovative projects and initiatives is an ideal site for teaching sustainable development through real-life case studies that challenge critical thinking and utilize problem-based learning.

This paper presents the findings of the research done to review and assess the current practice of Sustainable Development Education at engineering schools in UAE universities and colleges. Engineering schools are plentiful in UAE offering well-diversified education systems. The research also examines the different approaches that are followed in sustainable development education by the different education systems. The research further compares the current practice in UAE universities to those in the US. The research is done through literature review, questionnaires as well as personal contacts with respective authorities and faculty. The paper concludes with policy and curricula recommendations for Universities in UAE on sustainable education in engineering schools.

SDEWES.2009.515

## **Materials and Processes for Sustainable Energetics - a New Curriculum in Estonia**

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### **ABSTRACT**

New educational topics that need to be addressed in Estonia, as well as in other countries, include the new boundary conditions for energy use, i.e. the fact that energy cost is becoming more and more a critical issue for all players in the energy business, due to increased worldwide consumption on the one hand, and the need to restrict the production of green house gases on the other hand. Especially in engineering and natural science, this requires a fundamental change of the approaches taken and thereby the education given, a true change of paradigms. Instead of optimizing devices in isolation, the whole system must be considered; instead of analyzing systems starting only by considering different primary energy sources, we have also to analyze systems from the aspect of end-use; instead of being a problem for specialists it becomes a problem for generalists. The curriculum provides education in alternative energy materials science and engineering as well as in energy engineering in general at MSc level with a strong technology component. The curriculum offers an integrated approach towards current and long term materials and energy issues, focusing on technologies and concepts in sustainable development of industrial production and use of energy.

Thereby a new demand arises for people who are educated to deal with minimizing energy usage as well as with optimizing the conversion and production of energy. Qualifying such people is a new need for all countries and all types of schools. Here the higher education sector is addressed in which engineers (Masters of Engineering), as well as future scientists, are educated.

## Environmental Concerns

SDEWES.2009.542

### **Smart Protection from Environment Pollution Around Gas and Oil Equipment Using Knowledge of Corrosion Mechanism**

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#### **ABSTRACT**

Is very well known the serious problems, in respect with environment pollution, surround the storage and refinement gas and oil equipment. Economic and health cost has probably a lot significance in this case. The success in the fight against environment pollution is connection with a good knowledge of reasons for the equipment break down, which is corrosion. The last one is the guilty for release of hydrocarbon liquid, toxic H<sub>2</sub>S gas and other contaminant substances outside. Refer by, corrosion cause 25- 30% of the reasons for equipment breakdown in gas and oil industry. Studying of corrosion mechanism on areas of gas and oil transport pipe with stagnant conditions (where the possibility of failure is higher), using modeling of pipe in presence of three different fazes (brine solution, oil and gas in up part), in conditions of dynamic variation of temperatures ( $\Delta T$ ), presence of condensate, concentration of H<sub>2</sub>S in gas faze, etc. ECN measurement and metallographic investigation of cross section of the tube are using during the investigation of the corrosion mechanism.

SDEWES.2009.529

## **Indoor Radon Concentrations in The Town of Vushtrri, Kosovo**

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### **ABSTRACT**

Indoor air radon concentration was measured by exposing etched track detectors in the two elementary schools, one high school, a kindergarten and hospital in the city of Vushtrri. Measurements were performed with the radon monitor PRM-145, which uses alpha scintillation cells and serves to determine the current concentration of radon. The results we obtained are in the range between the average values of radon for the interior spaces, and values that pose a potential risk for lung cancer. Measuring the concentration of radon was done in total of 34 rooms and came up with values which are between 28 Bqm-3 and 398 Bqm-3. In order to reduce the concentration of radon, we have fixed a pump for ventilation and than we did measures for many time and than we got results between 130-145 Bqm-3.

SDEWES.2009.560

## **Marine Protected Areas (mpas) and The Coastal and Marine Management in The North Adriatic Sea**

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### **ABSTRACT**

In Italy the National system of MPAs developed during the 1980s and 1990s. The picture of established MPAs is characterised by many weak points: organisation failures, state-based approach, social conflicts regarding their management, very partial geographical and ecological coverage. The situation has however changed in recent time. New protection measures have been promoted and implementing, on the basis of the EU Habitat Directive. The present phase shows the increasing importance of the Regions in the design and implementation of protection policies. These place greater attention on public involvement and on the definition of more flexible management tools. However, in order to improve the environmental gains and implement sustainable forms of economic development these regional initiatives should be considered within a more comprehensive coastal zone management framework.

SDEWES.2009.081

## **Ecoducts: Criteria and Decision-making Process in Implementation of Technical Steps for Green Structures for Limitation of Fragmentation of Big Mammals Population**

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### **ABSTRACT**

Sustainability can also be understood as long-term compatibility. Its basic pillars are ecological, economical and social-cultural. From the ecological point of view there are three basic protection elements: protection of sources, ecosystems and human health. The use of natural sources must be evaluated not only from the point of view of price and quality but also it is necessary to consider all impacts on surrounding environment. In case of road structures, among which belong motorways and highways, it is necessary to deal with problems of possible defragmentation of biotopes leading to isolation of partial populations. Special green structures - so called ecoducts.

Ecoducts that serve primarily for animal migration or primarily for transfer of road over natural obstacle with secondary function of animal migration can be divided according to several criteria's. For example dependency of location of ecoduct with regard to surrounding terrain and road or according to animal category for which is ecoduct made. Among factors influencing design, location and function of ecoducts are width, surface treatment, surface ordering, location, technical equipment supplementary steps etc.

As a target species for which the ecoducts are designed, are under consideration virtually all animal species, which suffer by fragmentation effect. The position of structures must be determined by the location of those species with priority to reduce their barrier effect. The entrance area must include at least a peripheral part of territory with presence of the endangered species. Very negative influence on the population of mammals is the construction of new communication itself by taking their territories for communication. Influence, however, in practical life mean liquidation of individuals and not entire population. Much more serious impact has the traffic on new communication, which makes impossible to overcome the barriers. This effect is partially eliminated by a relatively dense construction of ecoducts. Authors describe in detail the criteria and decision-making process in the implementation of technical steps to reduce the fragmentation of populations of big mammals, with for example migration profile and by choosing ecoducts and its treatment.

SDEWES.2009.447

## **Ecological Remediation of The Šoštanj Thermal Power Plant with Respect to Sustainable Development of The Šalek Valley**

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### **ABSTRACT**

The Šalek Valley used to be exposed to huge amounts of pollutants due to its close vicinity to the largest Slovene thermal power plant of Šoštanj (ŠTPP). Due to large emissions of SO<sub>2</sub> and heavy metals as well as dumping of fly ash negative effects on the environment appeared (e.g. forest decline in the emission area of the ŠTPP, pollution of the lake Velenje and the river Paka). Therefore, several ecological remediation measures on the ŠTPP were implemented in 1990s, and several research projects on reasons and effects of forest decline and degradation of environment began as well. A continuous and well-pronounced improving of the condition of both forest and freshwater ecosystems (the lake Velenje and the river Paka) after the installation of desulphurization devices on Units 4 and 5 of the ŠTPP and construction of a closed loop system for the ash transportation is emphasized in the present paper.



SDEWES.2009.170

## **Legal Instruments to Control Harmful Anti-fouling Systems on Ships**

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### **ABSTRACT**

The paper deals with harmful environmental effects of organotin compounds used as anti-fouling system on ships. An analysis is made of the International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS-Convention), 2001 as well as the Regulation (EC) No 782/2003 of the European Parliament and the Council of 14 April 2003 on the prohibition of organotin compounds on ships and the Council Directive 76/769/EEC of 27 July 1976 on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations. The establishing of legal mechanism is elaborated for preventing the use of noxious substances as means that are used on the ship to control or prevent the attachment of unwanted organisms. In author's opinion the European environmental policy legislation is a regional environmental needs improvement and not a duplicate of the AFS-Convention aimed to reducing or eliminating adverse effects on the marine environment.

## Approaches to Sustainable Water Development: Case Studies II

SDEWES.2009.360

### **Small Water and Wastewater Systems and Emergency Settlements**

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#### **ABSTRACT**

The peculiarity of emergency settlements and/or buildings requires a still not developed research on small wastewater treatment systems.

Following sustainable principles, designers need to adopt an integral approach to discover simple but efficient strategies thus obtaining self-sufficient and low environmental impact buildings. To reach this aim it is important to consider different factors in relation to building technologies and materials, climate and socio-cultural environments, energy and water facilities which play a fundamental role for people wellbeing and health.

The paper examines different building solutions for emergency and temporary settlements properly addressed to satisfy housing demands in a sustainable way focalizing on possible and integrated small wastewater treatment plants: some of these derive from local traditions and use, other ones present more innovative solutions allowed by the technological development. These latter need to meet particular requirements in terms of flexibility, demountability, fast construction and simple maintenance.

SDEWES.2009.372

## **Optimization of Tajoura MSF Desalination Plant**

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### **ABSTRACT**

One of the promising projects has been being conducted by The Renewable Energy and Water Desalination Research Center (REWDRC) is the technology transfer project of thermal desalination plants, which is aimed to design and construct a once through multi-stage flash (MSF) and multi effect desalination plants (MED), both with a total capacity of 1200 m<sup>3</sup>/ day.

This paper presents an optimization study of the MSF desalination plant. The optimization problem is to maximize the gained output ratio (GOR) at different plant capacities by varying the top brine temperature.

A simple model devolved by Soliman et al, was used and modified to take into account the increase of feed stream salinity due to recycling of brine in winter season. The optimization problem was solved using Microsoft Excel software utilizing the SOLVER tool. Optimal operating conditions were obtained to vary the plant capacity to any desired value between 1000 and 1300 m<sup>3</sup>/day.

SDEWES.2009.403

## **Natural Organic Matter and Disinfection By-products Formation Potential in Conventional and Advanced Water Treatments**

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### **ABSTRACT**

Natural organic matter (NOM) is a complex mixture of organic compounds present in natural waters. NOM affects colour, odour and taste in water, as well as is a precursor of trihalomethanes after chlorination in drinking water. Chlorine, widely used as a drinking water disinfectant, reacts with the NOM present in raw waters leading to the formation of the disinfection by-products (DBPs). Many DBPs are classified into carcinogenic groups and their concentrations in drinking water have been regulated in EU, USA and by WHO.

NOM can be effectively removed by membrane processes, especially by ultrafiltration and nanofiltration (NF). In fact, NF has been widely studied and used to remove NOM from ground and surface water for drinking water production.

Since more stringent regulations are being implemented to control of DBPs in drinking water, it is important to analyse the removal efficiencies of the treatment sequences. Therefore, the objective of the present work is the evaluation of the NOM removal efficiencies by three different treatment sequences (one conventional and two advanced) and analyse the DBPs formation potential of those sequences. The three sequences analysed were: conventional sequence - pre-ozonation, coagulation/flocculation/ sedimentation (C/F/S), filtration and disinfection; and two advance sequences - pre-ozonation, C/F/S and NF, and pre-ozonation and NF.

Raw and treated waters were characterized in terms of MW, through the use of high-performance size-exclusion chromatography (HPSEC), dissolved organic carbon (DOC), UV254nm absorbance, turbidity, pH and conductivity. The specific UV absorbance at 254 nm (SUVA), the number-average MW (Mn) and the weight-average MW (Mw) parameters have been calculated. This characterization includes the amount of NOM removed and the qualitative changes in the NOM characteristics (MW and hydrophobicity) since they could be directly related with the DBPs formation potential.

The results demonstrate that, for the type of raw water analysed (hydrophilic with low DOC content), both treatment sequences remove larger MW compounds. However, the sequences with NF have a higher percentage of low MW compounds, when compared with conventional sequence, thus the water from NF sequences will have lower DBPs formation potential. In addition, the determination of the MW is very important since it leads to the understanding of the physical and chemical properties of NOM and the selection of the adequate treatment process.

SDEWES.2009.554

## **Small Reservoirs and Sustainable Water Use Under Global Change**

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### **ABSTRACT**

Small reservoirs generally serve to supply water for local use in more upstream locations in a river basin.

A case study on semi-arid North-East Brazil investigates distribution and sustainability of water use and global change scenarios, using climate scenarios, hydrological modelling, routing in reservoir networks.

Regional developments, leading to increased small reservoir numbers, will shift water availability upstream. Similarly, climate changes enhancing drought stress will have a spatially inhomogeneous impact on water availability and fulfilment of water demand.

## Advances in Thermal Power, Heat, and Cooling II

SDEWES.2009.400

### Improvement of Energy and Environmental Efficiency of Power Plants by Lowering Flue Gases Dew Temperature

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#### ABSTRACT

In this paper an influence of introduction (dosing) of gaseous ammonia,  $\text{NH}_3$ , into flue gases on lowering flue gases dew temperature is analyzed. It has been considered equilibrium mixture of reaction  $2\text{NH}_3(\text{g}) + \text{SO}_3(\text{g}) + \text{H}_2\text{O} \rightarrow (\text{NH}_4)_2\text{SO}_4(\text{s})$ . Equilibrium mixture composition calculation of the analyzed reaction indicates that introducing of ammonia into flue gases of  $100 \text{ cm}^3/\text{m}^3$  (0.01%) and with volume fraction of  $\text{SO}_3$  in flue gases of 0.1 up to  $10 \text{ cm}^3/\text{m}^3$  results in complete removal of all of the existing  $\text{SO}_3$ . This has as a consequence lowering of flue gases dew temperature and improvement of energy and environmental efficiency of power plants. Product  $(\text{NH}_4)_2\text{SO}_4(\text{s})$  obtained by ammonium introduction into flue gases together with a certain treatment, could be used as a nitro-fertilizer in agriculture.

SDEWES.2009.152

## **Modelling of The Performance of An Absorption Cycle Based on Liquid-liquid Phase Separation of Various Refrigerant-absorbent Pairs**

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### **ABSTRACT**

Due to environmental concerns, CFC and HCFC as well as certain refrigerants are phased out, due to their depletion (towards the ozone layer) (ODP) and the halocarbon global warming potentials (HGWP). Very severe restrictions concerning their use are continuously revised and imposed by the international community. Consequently alternative safe compounds and substitutes have to be developed and tested in energetically efficient machines. This is an arduous task due to the influence and interaction between various parameters such as:

- The reactivity towards the environment;
- The physical properties of the compounds involved;
- The thermodynamic properties;
- The efficiency;
- The compatibility with the machine.

The present work first considers the particular configuration of a refrigeration cycle which is based on Maxwell cycle which is globally similar to classical ones but with the major difference that in the generator a liquid phase separation takes place, avoiding any condensation of the vapour streams, which, usually, would have been obtained. It is tested in terms of coefficient of performance (COP) and it has not been subject to an extended study, a fact which has encouraged its further consideration.

A computer model is presented for this purpose, where a priori, the candidate pair (refrigerant-absorbent) to be used in the refrigeration cycle with phase separation, has to be selected. A huge number of binary liquid pairs exhibit phase separation at reasonable temperatures, but the lower the value of the critical solution temperature (LCST), the better is for the system performance.

Different systems extracted from the literature, with an organic compound as the absorbent and water as the refrigerant, have been tested at a large range of operating conditions in order to optimise the cycle COP values where quite interesting values can be obtained. One can cite (benzyl ethyl amine-glycerol), (water-Hexanoic acid), (water-

Hexanone), (water-ethyl propionate), triethylamine-water, 1- methyl pipyridine-water, (2,4 Dimethylpyridine-water, hexyl carbitol-water)), etc.

This study requires thermodynamic properties, liquid-liquid and liquid-vapour phase equilibria at various temperatures, pressures, compositions. Therefore predictive methods based on the group contribution concept have been applied and a thermodynamic model for this cycle has been developed, where equilibrium phase diagrams have been constructed.

In conclusion, this particular cycle configuration is promising and can be regarded as an interesting alternative both, environmentally and energetically, mainly due to hardware savings i.e. absence of condenser. Also many working fluids combinations can be tested systematically using the elaborated model, and hence providing a valuable tool for screening and design of potential compounds to be used in refrigeration systems similar to the one used in the present study.



SDEWES.2009.091

## **Current Spanish Biomass Co-firing Potential in Coal Power Stations**

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### **ABSTRACT**

The reduction of greenhouse gas (GHG) emissions is a relevant part in many of the current energy and environment policies in most of the European countries. Diverse alternatives are being used by the governments and the private companies to palliate the emissions and the costs derived from the emissions trade system. One of these possibilities for the CO<sub>2</sub> emission remediation is co-firing fossil and renewable fuels together, what implies the replacement of solid fossil fuels by renewable energy sources like biomass in already existing facilities. In Spain the consumption of solid fossil fuels accounts for more than 24 Mtep that represent 20% of total primary energy. The main solid fuel consuming sectors are the power generation sector (more than 82%) and cement industry (more than 7%). Therefore the co-firing technologies, specially in coal power stations, arise as a promising mean to reduce GHG emissions. The current paper presents results of the project ENE2005-00304/ALT (founded by the Spanish Ministry of Science and Education) on potentials for co-firing biomass in the Spanish coal based power generation sector. Forestry and agricultural biomass potentials have been obtained with best outstanding methodologies according to most detailed available data on Spanish forest and agricultural inventories. Geographical Information Systems (GIS) have been used to locate biomass at land-use resolution and to estimate biomass amounts and distances inside the influence areas (100 km radius around gravity centre) of the coal consumption zones. Results reveal existence of enough biomass resources to replace coal equivalent to a installed power capacity of 1000 MWe (more than 10% of the total coal thermoelectric power in Spain). Southern as well as north-east coal power stations present significant biomass resources able to replace more than 25% of coal. State of the art for co-firing has been revised to determine reasonable co-firing ceilings according to current attained percentages of coal replacement. Maps of biomass potentials, distance and cost of extraction and transport were useful to determine per consumption zone the curve of available biomass according to its plant-delivery cost. Biomass costs come out as the current bottleneck for biomass co-firing mainly for forestry biomass resources. On the contrary current herbaceous and ligneous agricultural biomass market prices result in savings for electricity producers.

SDEWES.2009.656

## **A Joule Cycle Ericsson Engine for Low Power Sustainable Energy Conversion**

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### **ABSTRACT**

An Ericsson engine is an external heat supply engine working according to a Joule thermodynamic cycle. It is shown that such engines are specially interesting for low power solar energy conversion and micro-CHP from conventional fossil fuels or from biomass. The design of an open cycle Ericsson engine with air as the working fluid is proposed. This engine works with a maximum pressure of 300 kPa, a maximum temperature of 650°C, and a maximum rotational speed of 950 rpm. The maximum shaft power of the engine is 3.8 kW with a global efficiency (defined as the ratio of the shaft power to the thermal power supplied to the working fluid in the heater engine) estimated to 25%. The proposed Ericsson engine is technologically simple and potentially cheap. A first prototype of the 'hot' part of the engine has been built and tested. Experimental results are presented.

SDEWES.2009.640

## **Through Application of Modern Power Generation and Information Technologies in Mines and Thermal Power Plants to Sustainable Development**

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### **ABSTRACT**

Coal is a key component of national energy security of Bosnia and Herzegovina because of its affordability, availability and abundance. Continuous goal of experts from Public Enterprise Elektroprivreda BiH and other scientific institutions is achievement of EU levels of efficiency, reliability, availability, flexibility and environmental protection for existing and especially for new Thermal Power Units. Generally, Bosnian types of coal are low valuable lignite and brown types of coal, with high tendency for fouling and slagging of boiler heating surfaces and high emissions of pollutants in flue gases.

Content and chemical compositions of the ash in coal have an important influence on the shape and size of the boiler furnace where pulverized coal is burned. In design of boilers with dry slag discharge furnaces and with slag tap furnaces, especially those used for combustion of coals which cause slagging and fouling, it is necessary to fulfill two requirements: slag tap chamber must be formed to provide an undisturbed flow of slag in molten state, and, furnace must be large enough to prevent forming of deposits of sintered ash and molten slag on furnace membrane walls and superheater surfaces. Primary measure to fulfil abovementioned requirements is to provide input (coal) of satisfactory quality.

Theory and practice have shown that precise investigation of coal at the mine and investigation of the optimal coal quality control organizational schemes including homogenization of coal represent key factors in achieving the abovementioned goals.

In the paper four organizational schemes of Thermo Power Plant coal supply system with implementation of information technology which continually monitors coal quality and electricity generation cost are presented. This would provide a basis for reorganization of Mines and Thermo Power Plants which would result in financial benefits which represent the base for sustainable development.

## Hydro, Wind, Geothermal III

SDEWES.2009.228

### Sustainable Use of Geothermal Energy Resources

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#### ABSTRACT

The length of time that is necessary for resources to regenerate is a crucial feature of natural resource economics. Many important resources, such as fossil fuels are created over geological ages and so their rate of supply is very slow. The rate of consumption of such resources is inevitably greater than their rate of regeneration. In contrast, for some resources, such as solar power, the rate of consumption will be less than or equal to the rate of supply (it cannot exceed supply) and there can be certainty that these resources will exist for a very long time into the future. As a result, use of these natural resources is much more 'sustainable'.

Between these groups of natural resources there is another group, such as biomass and water, for which the rate of consumption can be greater than rate of supply, making extinction of the resource possible if the point is reached where stocks cannot recover. This is unsustainable and more likely to occur with open-access (to ocean fisheries, for example). It is also possible with such resources, however, that the rate of consumption can be less than or equal to the rate of supply. Sustainable forestry and sustainable fishing operate on this principle.

Geothermal energy is a particularly interesting resource for study because the nature of this resource is such that it can move from being a renewable resource to being a non-renewable resource depending on the way in which it is exploited. This paper assesses the 'sustainable use' of a geothermal resource by determining its utilisation time (how long the geothermal reservoir will last) if the rate of consumption is greater than the rate of supply.

A further aspect of 'sustainability' of a natural resource is its environmental impact and this paper also identifies those impacts for geothermal resources. An assessment of the costs of carbon dioxide emissions from a geothermal resource is presented together with suggestions as to how to value other environmental impacts of geothermal energy.

SDEWES.2009.449

## **Heat Potential of Pumping-injecting Dublet Wells At Korovci in The Republic of Slovenia**

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### **ABSTRACT**

The Panonian basin is typified by a high geothermal flux and the presence of non-lithified and partially lithified porous clastic sediments. In the area of so called Mura depression water is present in deep aquifers in the Miocene and Pliocene sediments of Mura formation, Lendava, Murska Sobota formation and preterciary sedimentary rocks at depths between few hundreds to a few thousands meters. These deep aquifers in Miocene and Pliocene sediments are tapped for thermal water used by the health spas in the region. Due to pumping, the hydraulic head in the aquifer is dropping. To counter this effect, a solution to reinject used cooled water back into the deep aquifer was proposed on several places. A 3D structural model of the aquifer was made for special case of Korovci spa project. Hydrogeological and thermal properties of the aquifer were determined from the lithological profile of wells in the region, well-loggings and pumping tests. Using FEFLOW software, a thermodynamical model of the aquifer was made to determine the effect of the reinjecting well on the aquifer and evaluation of a proposed location for the reinjecting well at Korovci location.

SDEWES.2009.553

## **Opportunities for The Application of Groundwater Heat Pumps in Piedmont Region**

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### **ABSTRACT**

In this paper a multidisciplinary methodology for analyzing the opportunities for application of groundwater heat pumps is proposed. The approach starts from a model for calculation of a time profile of thermal requirements (heat and domestic hot water). This curve is then coupled with a off-design model of the heat pump and its control system in order to determine its operation along the period of analysis. This model allows one to calculate the heat pump energy performances (e.g. COP, primary energy consumption) as well as profiles of water discharge to the aquifer in terms of mass flow rate and temperature. Then the thermo-fluid dynamics of the aquifer is performed in order to determine the system impact on the environment as on possible other systems. The application to a case study in the Piedmont region, in Italy, is proposed.

SDEWES.2009.683

## **Into Geothermal: the Case of Challenge Stadium in Perth, Western Australia**

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### **ABSTRACT**

New technologies are being employed to extract heat stored beneath the Earth's surface. Geothermal energy sources have long been known to humanity, but new applications are based on innovative technologies which allow greater efficiency of low temperature resources. Specifically, these technologies can facilitate growth of decentralised infrastructure for generation of heat and in certain cases electricity in a carbon friendly manner. This type of decentralised energy infrastructure promotes sustainable development within cities.

The paper outlines the application of a low temperature geothermal resource within Perth, the capital city of Western Australia. The southern hemisphere's largest purpose built outdoor aquatic centre Challenge Stadium (which hosted the World Swimming Championships in 1991 and 1998) is now the site of Australia's most successful operating low temperature geothermal project - Challenge Geothermal. This award winning engineering solution was developed by Parsons Brinckerhoff (PB), world recognised engineering, planning and project management consulting firm.

Key benefits from Challenge Geothermal include:

1. Reduced consumption of fossil based fuel (geothermal energy replaced 29TJ of gas) with estimated savings of up to 1300 tonnes of CO<sub>2</sub>e/year;
2. Cost savings in running the stadium (estimated above AUD \$200000/year), with a return on investment within 6 - 7 years;
3. Water supply and water infrastructure development for a local school through a water neutral technological design (an example of how decentralised infrastructure is beneficial for local partnerships);
4. Enhanced sustainability profile for the sports and recreation facility.

However, for cities that are established in geothermally rich environments, the greatest potential benefit from this type of project is the promotion of sustainable development. Within Perth, Challenge Geothermal is an excellent example of growth in accordance with the CASE (Cities as Sustainable Ecosystems) principles, where each geographic area supports locally appropriate technological solutions aligned to the ecological status of the area. Such projects can be seen as sustainable as they are ecologically friendly whilst benefitting the community and economy of the city.

## Hybrid Renewable Energy Systems

SDEWES.2009.535

### **Electromagnetic Pollution Analysis of a Hybrid Photovoltaic-fuel Cell Energy System**

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#### **ABSTRACT**

In the modern life, extensive use of electrical energy affects human health. Especially effects of electromagnetic pollution should be investigated. In any energy system, the components which disperse high electromagnetic pollution should be determined to take some actions against the electromagnetic pollution. Hybrid Renewable Energy Systems (HRES) which consist of more than one renewable energy source have become important to utilize in small and large scale buildings. However, main components, photovoltaic panels, wind turbines, fuel cell systems, used in these systems produce electrical energy as well as electromagnetic pollution. In this study, an electromagnetic pollution analysis of a hybrid photovoltaic-fuel cell system installed at Pamukkale University in Denizli, Turkey is performed. Electromagnetic pollution intensities emitted by components of the installed hybrid energy system are measured under different loads. In addition, results of measurements are compared with worldwide standards. An electromagnetic pollution map is developed by using Matlab and Mapinfo computer softwares with obtained data in order to extract an electromagnetic pollution profile of the hybrid energy system.



SDEWES.2009.010

## **The Small PV–wind Hybrid Grid Connected System**

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### **ABSTRACT**

This paper is to present the study and development of small Photovoltaic-Wind hybrid grid connected systems. The aim is to design configurations and installation the PV-Wind hybrid system for academic purposes. This system was installed in Nonthaburi Thailand. The system resources consisted of 1642 Watts of Amorphous Silicon PV module, and 1000 watts of permanent magnet wind turbine. The power converter comprises of two difference types of grid-connected invertors. Then developed the PC based monitor system by LabView. The experimental period was for three months. The results showed that the electrical energy generated from this hybrid system is equal to 5.181 kWh/d. The 5.031 kWh/d from the PV-grid system, and 0.15 kWh/d from the Wind-grid system. The efficiency of invertors in PV system is equal to 83.30%, and 82.44% from the wind system. The PC based monitor system works perfectly. The small PV-Wind hybrid system could be use appropriately for academic purposes.

SDEWES.2009.253

## **Dynamic Modelling and Simulation of Stand-alone Hybrid Generation System with Solar Photovoltaic Energy, Wind Energy and Hydrogen-based Energy Storage**

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### **ABSTRACT**

Renewable energy sources, as energy alternatives, have attracted special attention all over the world, in order to increase the security of energy supplies by reducing the dependency on imported fossil fuels and to reduce the emission of greenhouse gases.

Renewable energy sources like wind and solar photovoltaic energy are being widely used, since they are abundantly available in nature and the used technology is now well developed. However, one of their major advantages is the random, fluctuating nature, which makes them unpredictable or even unreliable compared to traditional supplies of electric energy.

This paper describes the model and simulation results of a renewable energy based hybrid generation system for stand-alone applications. In such a case, different energy sources and converters need to be integrated to meet sustained load demands while accommodating various natural conditions.

The paper focuses on the combination of photovoltaic cells (PV), wind turbine (WT) and hydrogen-based energy storage systems for power generation. The hydrogen-based energy storage is composed of an electrolyser (EL), which uses electricity to generate hydrogen from water, a hydrogen storage tank and a fuel cell (FC), which recombines hydrogen with oxygen to generate electricity.

As the WT output power varies with the wind speed and the PV output power varies with both the ambient temperature and radiation, a hydrogen-based energy storage system is integrated to ensure that the system performs under all conditions, even when there is insufficient wind or solar radiation.

In the proposed system, at times of excess renewable energy (WT or PV), the electrolyser is used as a controllable load by which the excess energy is converted into hydrogen gas. At other times, when there is insufficient renewable energy to meet the demand, the fuel cell is used to generate electricity.

This paper presents a dynamic simulation model using Matlab/Simulink simulation environment to study the behavior of renewable energy based hybrid generation system for stand-alone applications. It is tested under various wind speed, solar radiation and load demand conditions. The developed model and its control strategy exhibit excellent

performance for the simulation of a complete day. In the simulation, the solar radiation, the wind speed and power demand data are based on real world measurements.

The results show that the proposed hybrid generation system is an excellent option for stand-alone applications, since it is able to adapt to the rapid changes in natural conditions and load demand, ensuring the load supply in any case, even with insufficient renewable energy.

SDEWES.2009.443

## **Microgrids: Pilot Test Location in Macedonia**

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### **ABSTRACT**

Microgrids comprise low voltage distribution systems with dispersed energy sources, storage devices and controllable loads, operated connected to the main power network or islanded, in a controlled, coordinated way. The operation of microgrids offers distinct advantages to customers and utilities, in terms of improved energy efficiency, minimization of overall energy consumption, reduced environmental impact, improvement of reliability and resilience, network operational benefits and more cost efficient electricity infrastructure replacement. Additionally, as the microgrids concept is based on utilization of dispersed energy sources, this concept stimulates wider use of renewable energy sources available on locations positioned in close proximity of the end customers.

This paper presents the envisaged test pilot microgrid in Macedonia, developed within the framework of the FP6 MOREMICROGRIDS project. The test network consists of a part of the low voltage grid, located on a pig farm. The main electricity source for the microgrid is a small biogas plant, which uses the biogas produced by a waste water treatment process on the farm, based on anaerobic digestion. The paper addresses the pilot microgrid design and development of scenarios which should be tested.

This location is the first of its kind being developed in the Western Balkan region and should serve as pilot site for introduction and examination of the new concept in non-EU conditions. The tests performed on the location should create extensive base of data to enable exploration of the potential for wider microgrids deployment in the country and wider.

SDEWES.2009.056

## **Techno-economic Assessment of An Autonomous Renewable Energy System Based on Hydrogen Production**

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### **ABSTRACT**

The main objective of this work is to model a renewable energy system that meets a known electric load with the combination of a photovoltaic (PV) array, a wind turbine, an alkaline electrolyzer and a PEM fuel cell. The analysis utilizes the power load data from a small hypothetical hotel that can be located in different places in Greece. There are three regimes in which the power manager can operate:

a) In the first regime, there is more power supply from renewable sources than is required by the load plus the load safety factor and any excess power is used to run the electrolyzer in order to generate hydrogen. The produced hydrogen is stored in pressurized tank.

b) In the second regime, there is more power produced from the renewable sources than is needed to meet the load but not enough to meet the load plus the load safety factor. In this case, the load is met and any excess power is dumped.

c) In the third regime, power from the renewable sources is less than the power demands of the hotel. In this case, the electrolyzer is OFF while the fuel cell is ON in order to meet the load.

The modeling, control and simulation of the proposed system were performed using TRNSYS software. The HOMER software was used as the optimization tool.

Different combinations of PV, wind turbine, electrolyzer, fuel cell and tank sizes were selected in order to determine the optimal combination of the system on the basis of the Net Present Cost (NPC) method.

## Greenhouse Gas Emissions, Impacts and Countermeasures I

SDEWES.2009.215

### **Modeling the Dependence of The Climate System on The Carbon Dioxide Emissions from Fossil Fuel Combustion**

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#### **ABSTRACT**

We have developed a model for investigating the dependence of the climate system on the concentration of carbon dioxide in atmosphere. This model was constructed in the STELLA program, which makes use of Systems Dynamics Modeling as a methodology. It consists of two main sectors: climate sector and carbon dioxide emissions sector, and studies interactions between climate system and carbon dioxide emissions from coal, oil, natural gas... Together, the interacting climate and carbon dioxide emissions sectors provide predictions of both Earth and atmosphere temperature as a function of time. The model predicts a gradual increase in atmosphere and Earth temperatures. The increase of mean temperatures for the time interval of 100 years is about 5 K, which is in accordance with the data obtained from IPCC where the range of projected global temperature change, for the same time interval, for all scenarios is 1.4 K to 5.8 K.

SDEWES.2009.001

## **Long-term Dynamic Effects of Carbon Tax Based on The Imputed Price of Carbon**

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### **ABSTRACT**

An international carbon tax is one of the remarkable ways to efficiently abate CO<sub>2</sub> emissions. However, if an internationally common carbon tax (CCT) is introduced, it might be a heavy burden for poorer countries. A carbon tax based on the imputed price of carbon (ICT) is an international carbon tax with tax rates that differ among countries according to their economic levels. This concept was shown in Uzawa (1991) and Matsumoto (2006, 2007, 2008) analyzed the effects applying the CGE model. Due to the features of the tax, CO<sub>2</sub> emissions abatement can be realized considering economic equity among countries simultaneously. From the above studies, it was shown that CO<sub>2</sub> emissions abatement was realized without serious economic damage on developing countries by introducing ICT relative to CCT. Since these studies were done in a static basis, it was not possible to deduce from them what would happen in the future. However, considering the features of the tax, understanding the dynamic effects is significant. The purpose of this study is to analyze the long term impacts of ICT on environment and economy relative to CCT by applying a dynamic CGE model.

The model in this study is a global dynamic CGE model with 24 regions and 21 sectors. The base year is 2001 and simulation is implemented until 2100. Both taxes are introduced from 2010. In the model, although not only CO<sub>2</sub> but also other GHGs are considered, the taxes are imposed only on CO<sub>2</sub> emissions. The ICT rates are calculated based on a certain formula and updated every year. On the other hand, the CCT rate is set to achieve an equal change in global GDP in 2050 and 2100 to the case of ICT.

As a result (in 2100), the world CO<sub>2</sub> emissions abatement amount is almost the same between ICT and CCT (a bit larger in the case of CCT). However, the economic impact on each region is quite different. While the changes in world GDP are equivalent for both cases according to the assumption, the patterns of the changes are different. The negative influence is smaller in the case of CCT for developed countries, but it is smaller in the case of ICT for most developing countries. Moreover, the percentage of GDP of the developing countries in the world becomes higher in the case of ICT. This means that economic disparities between the developed and developing countries are narrowed more. Also, not merely low tax rates are imposed on the developing countries but the rates are updated repeatedly according to the economic growth, hence the difference of the rates among the countries is expected to be smaller as they grow higher and faster. Actually,

increase rates of ICT are larger in these countries. Especially in China, India, and Brazil, the rates become the same levels as the developed countries.

It is necessary to consider economic aspects more for future climate change policies (e.g. the Article 3 of the UNFCCC). In addition, it was shown in Matsumoto (2006, 2007, 2008) that CO<sub>2</sub> emissions abatement effect became much smaller in the case of CCT introduced without developing countries than that of ICT. In the light of the importance of worldwide introduction of CO<sub>2</sub> abatement policies and avoidance of excessive economic burdens on developing countries, ICT is regarded as a highly feasible carbon tax policy.



SDEWES.2009.164

## **A Projection for Global CO<sub>2</sub> Emissions from The Industrial Sector Through 2030 Based on Activity Level and Technology Changes**

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### **ABSTRACT**

In this paper, CO<sub>2</sub> emissions from industrial sector and its reduction potentials are projected through year of 2030. We develop a simulation system which consists of three parts.

The first part simulates macroeconomic indicators such as GDP and sectoral value-added by a macro economic model. The model is a supply-side model which estimates GDP from capital stock and labour force and determines other macro economic indicators based on the GDP.

The second part simulates future levels of industrial activities such as steel production and cement production with using macro economic indicators as input. As for the steel production, we develop a model which considers international trade of steel, since significant amount of steel is traded internationally in actual world. The model is partial equilibrium model in which domestic and international market reach equilibrium simultaneously. As for the cement production, we develop a model which determines each region's production based on the domestic demand, since cement is not widely traded among regions. As for the other industries, we don't assume a specific product to indicate the activity level. Instead, we use industrial value-added in real term, which is projected by socio-economic macro frame model, as the alternative indicator to represents the activity level of the other industries.

The third part simulates CO<sub>2</sub> emissions and reduction potentials by bottom-up type technology model which uses industrial activity level as input. The model considers 86 technologies and estimates how much those technologies are used in the future. It depicts dynamics of recruitment and retirement of technologies to estimate amount of stocked technologies in each year. We assume economically rational behaviour of industrial companies in deciding recruitment and retirement of technologies and mathematically formulate the model as a cost minimizing problem.

By using this system, it is simulated that world GDP growths at an average annual rate of 3.2%/year in real term from 2005 to 2030. And world CO<sub>2</sub> emissions in 2030 are estimated to be 25 GtCO<sub>2</sub> which is 2.6 times those for 2005 in the case of no technology change. However, it is also estimated there is a reduction potentials, from no technology change case, of 4.7 GtCO<sub>2</sub> and 6.3GtCO<sub>2</sub> under the marginal cost of 0 US\$/tCO<sub>2</sub> and 100

US\$/tCO<sub>2</sub>, respectively. And it is shown reduction potentials in China and India is notably large which account for 65% of world reduction potentials.

SDEWES.2009.151

## **Assessment of The Potential for CO<sub>2</sub> Capture and Storage Technologies in European Heavy Industries**

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### **ABSTRACT**

The main goal of the European Union Emission Trading Scheme (EU ETS) is to reduce CO<sub>2</sub> emissions from a number of key sectors in the European energy system, i.e. emissions from large stationary sources in the energy and industrial sectors. Costs and capacity to deal with the challenges associated with emission reductions vary across sectors and between individual installations. The distribution of CO<sub>2</sub> emissions in the various branches of the industrial sector depend not only on their energy intensities but also on their share of direct process related emissions and on their fuel and feedstock mixes. Many European industries have already managed to lower their CO<sub>2</sub> emissions considerably through increased energy efficiency and through alterations in production processes and in fuel and feedstock mixes. The prospects for further emission reductions are thought to be relatively limited. Therefore, to obtain more extensive emission cuts new, low carbon, process technologies have to be developed and deployed.

This study aims to assess the role of CO<sub>2</sub> capture and storage (CCS) technologies in contributing to reduced CO<sub>2</sub> emissions in the European energy and industry sectors. The assessment adds on to an earlier investigation of the potential for CCS in the European electricity generation system. Emphasis is here placed on three industrial branches with promising prospects for CCS; mineral oil refineries, iron and steel, and cement production. A relatively small number (~250) of large emitters (>500000 tCO<sub>2</sub>/year) dominates emissions from these three branches. Together these installations emit 380 MtCO<sub>2</sub>/year, 7% of EU's total greenhouse gas emissions. The assessment of the role of CCS in these three branches is based on facility level data on key processes and plant components related to energy use and CO<sub>2</sub> emissions. Critical factors for the potential and deployment rate for CCS technologies in heavy industries are:

Location of the plants in relation to other large CO<sub>2</sub> emission sources, i.e. to facilitate integrated transportation networks to suitable storage sites.

Capital vintage structure, i.e. investments in CO<sub>2</sub> capture technologies are likely to coincide with other shifts in the production process.

The paper discusses these factors based on a first estimate of the potential of CCS on more than 700 large CO<sub>2</sub> point sources in the European energy and industry sectors and presents a number of regional clusters suitable for a CCS rollout.

SDEWES.2009.024

## **Comparison of Tools for The Ecological Tax Reform**

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### **ABSTRACT**

The member states of the European Union have a duty to implement the directive 2006/96/EC. This directive orders the states to apply ecological taxes on energy products and electricity.

There are more kinds of energy products which are subject to tax: leaded petrol, unleaded petrol, gas oil, kerosene, LPG, natural gas, coal, coke, and electricity.

The ecological tax is an excise tax, which has the goal to include the price for environmental damage in the price of an energy product. There are several reasons to apply the ecological taxes on the energy products. One of the most promoted reasons is the intention of the European Union to reduce the current amount of the consumed energy products and thus to save the public good.

There is also another idea behind the ecological taxes which says that the ecological tax as a kind of an excise tax is "fairer" than the pay-roll tax, because every tax is actually a kind of a penalty and the government does not want to penalize those who work. The idea suggests that the better way is to impose tax on the purchased products whose consumption can be reduced or even fully cut down with positive impact on the environment. Hence the ecological tax is a device to internalize the externalities of the human activity according to the polluter-pays-principle.

The ecological taxation is not the only tool which can be used to conduct the ecological tax reform.

The other tool which can be used to achieve the aims of ecological tax reform is the emission trading system and the emission allowances. The emission allowances are a financial burden put on the amount of CO<sub>2</sub> produced in the industry.

We also know other tools; let us mention the main, which are:

- subsidies
- voluntary agreements
- savings
- technological improvements

The goals of the ecological tax reform are to increase the environmental protection and to increase the economic system efficiency.

The aim of this paper is to compare the individual tools which can be used to achieve the goals of the ecological tax reform and to assess their impact and their advantages and disadvantages. This comparison can be further used for decision making in the environmental protection.

## Towards Sustainable Combustion II

SDEWES.2009.313

### **Study on a Bioethanol Solar Reforming System with The Solar Insolation Fluctuation in Consideration of Heat Chemical Reaction**

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#### ABSTRACT

The greenhouse gas discharge due to distributed small fuel cells changes greatly with methods of hydrogen supply. Thus, we are examining a system using the heat obtained from a small sunlight solar collector to reform of bioethanol into a vapor (fuel cell system with bioethanol solar reforming system (FBSR)). We propose that hydrogen will be produced when installing FBSR in a home, and we aim to use a layered neural network as the weather forecast method. However, all the analysis in this paper assumes steady-state hydrogen production.

By supplying the ethanol steam (fuel steam) to a catalyst layer, the reforming reaction is advanced at FBSR. Generally, a fuel inversion rate is obtained by using the temperature of the catalyst layer and the space velocity of the fuel steam. In this paper, nonsteady heat analysis is introduced into the catalyst layer that is in the reforming component. From this analysis, the distribution of temperature, inversion rate, and process gas composition is investigated. From this, the hydrogen generating rate in the non-steady of FBSR is obtained. The solar insolation input into the acceptance surface of the reactor that is filled up with the catalyst fluctuates according to the weather. If the heat transmission characteristics of the catalyst layer are taken into consideration, it will be expected that the amount of hydrogen production of FBSR is influenced by solar insolation fluctuation over a short time. Accordingly, if the solar irradiance input into the acceptance surface of the reactor fluctuates many times in a short period, the time of the reforming reaction will not be enough. Therefore, the amount of hydrogen production of FBSR changes with characteristics of the fluctuation of solar insolation. The purpose of this research is to determine the characteristics of the amount of hydrogen production and the efficiency of the reforming component under the circumstances of global solar radiation with fluctuating inputs to the acceptance surface on the reactor of FBSR. "The higher calorific value of hydrogen / the amount of heat collections per day" defines the efficiency of the reforming component.

SDEWES.2009.320

## **Mathematical Prediction of Methane Formation in An Anaerobic Co-digestion Cstr**

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### **ABSTRACT**

An innovative solution for the Organic Fraction of Municipal Solid Waste (OFMSW) treatment is the combined digestion (co-digestion) with sewage sludge in the anaerobic digesters of the municipal wastewater treatment plants (MWWTPs). The feasibility of this solution deserves a relevant attention in Countries, such as Italy, where many MWWTPs include oversized reactors for the anaerobic digestion of sewage sludge and are located next to the solid waste production sites. Anaerobic co-digestion results in production of biogas containing over 50% methane. The utilisation of this gas in power generation can provide the energy supply for the MWWTP, whereas the biogas surplus can be used as energy renewable source.

The studies reported in literature indicate that the optimal operational conditions in terms of percentages of the OFMSW and sewage sludge cannot be univocally defined but should be investigated for each specific case. Moreover, with regard to the physical and biochemical processes prevailing in a co-digestion system, only some aspects have been investigated. This paper presents a modelling/experimental study on the anaerobic co-digestion of the OFMSW and sewage sludge aimed at defining process optimization criteria and coming to the determination of the main benefits and applicability limits of the system. The mathematical model proposed is able to simulate under dynamic conditions the physical, chemical and biological processes prevailing in a OFMSW and sewage sludge anaerobic digestion system. This model is mainly based on the IWA Anaerobic Digestion Model n°1, whereas a different approach has been used to simulate the OFMSW disintegration process, which is a fundamental step when the substrate to be disintegrated is highly complex as the OFMSW. Numeric integration of the differential equations is performed using the software tool Matlab.

Several simulations have been carried out aimed at investigating the effects of the process operational conditions in terms of OFMSW/sewage sludge ratio, temperature, OFMSW particle size, solid mixture retention time, reactor stirring rate, etc. The model can also be used to optimise the digester operation in order to avoid conditions leading to instability and subsequent failure of the co-digestion process.

SDEWES.2009.469

## **The Application of Statistical Thermoenergetics for Calculation of Combustion of Natural Gas**

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### **ABSTRACT**

The detailed knowledge of natural gas combustion phenomena is very important for energy technologists, ecologists and scientists involved in combustion process. The presented paper features the mathematical model of computing the chemical and thermophysical properties in process of natural gas combustion. To identify the parameters of state of combustion products their composition has to be known, which may be determined from chemical equilibrium. The computation is performed by the use of chemical potentials and use of statistical thermodynamics. The paper features all important molecular contributions (translation, rotation, vibration, and intermolecular potential energy) Thermal equation of state with two virial terms is used. The reality of the gas mixture is considered with two components: carbon dioxide and water. Virial coefficients are dependent on temperature and mole fractions of the real components. Mixed terms are considered. The caloric equation of state is based on ideal gas statistical thermodynamics. Considered are corrections according to the second law of thermodynamics and thermal equation of state. As the whole computation is based on matrix algebra the expansion of the component number under consideration does not represent any problem. We tested our model in high pressure region (100 bars) and low pressure region (1 bar), between temperatures 500-6000 K. Our analytic model is compared with other analytical models presented in the literature and show relatively good agreement. At the same time we tested the influence of reality on chemical and thermophysical properties of combustion products.

SDEWES.2009.438

## **Co-pyrolysis of Coal and Biomass Blends: Char and Oil Characterization**

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### **ABSTRACT**

In this study, the co-pyrolysis of coal and biomass blends and characterization of solid and liquid products were studied. Lignite and hazelnut shell were used for coal and biomass. Mass ratios of 100:0, 75:25, 50:50, 25:75 and 0:100 lignite:hazelnut shell were pyrolysed in a fixed-bed Heinze reactor with a heating rate of 10°C min<sup>-1</sup>, to a final temperature of 750°C in inert N<sub>2</sub> atmosphere with a flowing rate of 100 cm<sup>3</sup> min<sup>-1</sup>. Mean particle sizes were 0.75 mm for lignite and 1.25 mm for hazelnut shell. Elemental analysis was used to investigate the characterization and FT-IR spectra was used to analyze the functional groups of coal, hazelnut shell, char and oil products. Pyrolysis oils were also examined by chromatographic and spectroscopic analysis techniques using GC-MS and <sup>1</sup>H NMR. Surface areas were calculated by BET equation and scanning electron microscopy (SEM) was used to investigate the changes in the surface structure of coal, hazelnut shell and chars. Solid product yield decreased from 60% to 29% with the increased hazelnut shell ratio, but on the other hand the liquid product yield increased from 10% to 27%. According to the experimental and characterization results liquid products were found to be compatible with petroleum fractions and solid products were compatible with commercial activated carbons.



## Sustainable Transport II

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SDEWES.2009.395

### **Transportation Demand Modelling - a Tool for Pollution Estimation**

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#### **ABSTRACT**

Modern software tools give the possibility of generating a lot of development scenarios of street network system, which can be tested quickly. Transportation models are good (and necessary) basis in the procedure of environmental traffic effects and energy emission estimation. Research in this paper deals with the possibility of using transportation modelling as a tool for estimation of some air pollution and global warming indicators on street network, coming from personal cars with the internal combustion. These indicators could be the basis for defining some planning and management solutions in transport system in the aspect of their environmental influence. All the analyses are based on several years of research experience in Belgrade. According to the emissions of gasses from the model, the values of other GH gases can be estimated, using the known relations between the pollutants.

SDEWES.2009.361

## **Development of a Practical Driving Cycle for Simulation of Car Emissions: a Case Study in Aleppo City, Syria**

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### **ABSTRACT**

Driving cycles in such a city are analysed by researchers in the same approach in many countries. Due to recent advancements in some software packages utilized to estimate vehicle emissions, many projects have been conducted on establishing the drive cycle of a specific area/city. In this paper, a preliminary case study on the estimation of the emission values taken from a passenger car has been carried out. An On Board Diagnostic (OBD II) reader has been used and configured to extract the data and save it in a built-in data acquisition package in order to estimate an instantaneous emissions produced from a vehicle.

A representative driving cycle reflecting the real-world driving conditions was achieved and estimated vehicle emissions were validated. This method is user-friendly and the results were shown to be accurate as real data from Aleppo city was used.

SDEWES.2009.688

## **Strategic Analysis of Air Transport Industry**

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### **ABSTRACT**

Competition is often regarded as the ultimate solution for market efficiency. In certain sectors, however, market imperfections together with scale and scope economies lead market participants to establish some sort of cooperation efforts in order to maximize the common benefit of the cooperating partners. We argue that this is increasingly the case with the air transport industry in Europe and elsewhere.

In this article we analyse the economic rationale behind strategic alliances in the air transport sector, namely emphasizing the individual contributions and collective benefits of airlines when merged within a specific alliance for cooperation purposes. The several possibilities of cooperation agreements between air carriers are also analysed, as well as some of their managerial implications.

Finally, the implications for tourism and the prospective medium-term trends for the airline sector are also taken into consideration for the immediate future of this competitive market, notwithstanding the competitive pressures ahead, namely the ones stemming from IT innovation and increasing energy costs.

SDEWES.2009.274

## **The Importance of Assessing Environmental Loadings of Transport Services in An LCA**

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### **ABSTRACT**

Today it is consensus internationally that the global transport system is not sustainable. There is an agreement that without substantial change in Governmental policy this trend will continue (Holden and Høyer 2007).

A necessary prerequisite for successful change of policy and action is basic knowledge about the energy and environmental impacts of different transport systems. It is necessary with a thoroughly methodological discussion about life cycle assessment (LCA) of transport services. In the present research the goal is to illustrate the importance of transport when conducting an LCA.

During recent years there has been a shift in how goods are transported. Air transport (1% of the intercontinental freight transport by volume, but 40% of value of transported goods), and road transport have increased. Sea transport has only increased slightly and rail transport decreased in EU countries (Neiberger 2009).

The energy use from transport activities makes up 30% of the total CO<sub>2</sub> emissions from the OECD countries (Holden and Høyer 2007)

As a case for illustration off global transport of goods we use the production of a cathode for aluminium production. Transport is an environmental hotspot in cathode production. The case highlights that LCA needs not just to look at product efficiency problems. Societal challenges such as pattern problems i.e. the choice between transport modes and volume problems e.g. the increased transport of goods should also be addressed in an LCA (Andersen 2003)

To compare different means of transport we must distinguish between indirect, direct and gross direct energy usages for different means of transport. This categorisation includes manufacturing and maintenance of means of transport, as well as construction, operation and maintenance of infrastructure and direct energy use of the transport means. It is also important to have a comparable approach for environmental impacts, energy and land use of automotive, bus, boat, train and flight transports from cradle to grave. This means that categorisation should be made as equal as possible. First of all, a transport system LCI must be consistent regarding the system boundaries. Secondly, the environmental impact analysis must be consistent with regard to level of transport technology. Third, it is only worthwhile to compare transport systems that are real alternatives to each other (Holden and Høyer 2007).

## Greenhouse Gas Emissions, Impacts and Countermeasures II

SDEWES.2009.383

### **Development of The System for GHG Emissions Quantification and GHG Reduction Potential Estimation from Dispersed Sources of Pollution**

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#### **ABSTRACT**

Ratification of Kyoto Protocol and the intention to become developed and environmentally responsible country define new challenges for Serbia, its government, experts and local communities. Data acquisition and processing related to quantification of greenhouse gasses (GHG) emissions and estimation of the potential for their reduction is necessary in order to fulfill obligations related to creation of the National GHG Inventory and meeting other environmental goals, defined either by the state itself or by the European Union.

This paper illustrates the authors' vision of technical and organizational aspects of quantification GHG emissions and estimation of the potential of their reduction process and presents one part of the research performed in order to facilitate Serbian Government establishment of the entire system. The research, as well as the paper, is related only to GHG emissions from dispersed sources, i.e. small facilities with stationary combustion processes with the purpose to provide heat for public, commercial and residential objects.

Relevant data, collected and organized, will be used for GHG reduction potential estimation, local energy planning, national energy strategy and national GHG Inventory. The main idea is to perform collection of most information at the same time when the data for local energy balances are collected. This data are planned to be collected by the local energy managers of different levels and external consultants. The system for processing the information will contain the software able to accept information on energy consumption, fuel characteristics, combustion products composition, as well as the

information on the characteristics for each object. This software, described in this paper, should also serve to estimate the potential for GHG emissions reduction and energy savings according to the defined procedures, entered data as well as according to the referent values and procedures defined in the 2006 IPPC Guidelines for National GHG Inventories and supply all the data to a single database. The greatest challenge is collection of data for residential object, which is explained in the paper in more detail.

SDEWES.2009.135

## **Modeling CO<sub>2</sub> Emissions Impacts on Croatian Electrical System**

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### **ABSTRACT**

Today's electrical energy landscape is characterized by new challenges such as deregulation, liberalization of energy markets, increased competition on different energy markets, growing demands on security of supply, price insecurities and demand to cut CO<sub>2</sub> emissions. All mentioned challenges are calling for consideration of various options (like nuclear, coal, gas or renewable scenarios) and for better understanding of energy systems modelling in order to optimize proper energy mix. Existing models are not sufficient anymore and planners will need to think differently in order to face these challenges. European emission trading scheme (EU ETS) started in 2005 and has great influence on electrical system short term and long term planning. Croatia is obliged to establish a national scheme for trading of greenhouse gas emission allowances from the year 2010, which will be focused on monitoring and reporting only until accession to EU when it will be linked with EU ETS.

Thus, for Croatian electrical system it is very important to analyze possible impacts of CO<sub>2</sub> emissions. Analysis presented in this paper is done by two different models: mathematical model, based on short run marginal costs (relevant for fuel switch in existing power plant and merit order change) and long run marginal costs (relevant for new investment decisions); and electricity market simulation model PLEXOS, which was used for modelling Croatian electrical system during development of the Croatian Energy Strategy in 2008.

Results of the analysis show important impacts that emission trading has on Croatian electrical system, such as influence of emission price rise on price of electricity and on emission quantity, and change in power plants output that appears with emission price rise.

SDEWES.2009.090

## **Cofiring Versus Biomass-based Power Plants: GHG Emissions Savings Comparison Among Different Biomass Resources Utilisation by Means of LCA Methodology**

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### **ABSTRACT**

One way of producing nearly CO<sub>2</sub> free electricity is by means of using biomass as a fuel. However, it has to be considered that when biomass entire life cycle is assessed still there are Greenhouse Gases (GHG) emissions due to cultivation, harvesting, processing and transport processes, generally use fossil fuels.

For bioelectricity purposes biomass-only fired power plants and biomass cofiring could be considered. Two important aspects that should be analyzed are which the most interesting alternative is when GHG emissions are taken into account and, secondly, which biomass resources allow the achievement of the highest impact reduction in each case. Three different types of biomass have been assessed, wheat straw and two different energy crops: *Brassica carinata* and *Populus* sp. Their different and specific characteristics concerning the amount of fertilizers, fuel consumption and pretreatments required, etc, involve differences among their final GHG emissions.

In order to quantify the GHG impacts offered by each system a Life Cycle Assessment (LCA) was performed. Additionally, some sensibility analysis of the most important parameters and the comparison between the obtained results were obtained.

This paper approaches the answers of which the real net CO<sub>2</sub> emissions decrease is when bioelectricity is implemented and which the best alternative is when considering a fixed resources quantity: a biomass-based or a cofiring power plant. Assessment of the GHG emissions reduction achieved in a cofiring system is quite important since it affects biomass utilisation profitability due to its relationship with emissions trading and, related to this, to the incomes finally obtained. Besides, the results will allow policy makers to determine preferences or grants among biomass conversion alternatives. Additionally, the results will allow technicians to identify the differences among considering some different representative types of biomass as a fuel for the two alternatives assessed.

This paper deals with the same topic that one which was already presented two years ago dealt with, although this paper besides considering data related to crops production and management obtained from specific tests carried out in the Teruel province (Spain) which have increased the accuracy, also includes important methodological improvements



based on the proper work carried out by the authors and on the comments and reviews that were done by the Energy journal referees.

SDEWES.2009.303

## **GHG Emissions Reduction in a Power System Predominantly Based on Lignite**

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### **ABSTRACT**

In this paper the GHG mitigation potential of a power system with prevailing use of lignite (over 70%) is assessed through the example of the Macedonian power system. The mitigation analysis is conducted by making use of WASP model in order to develop three different scenarios (business as usual - BAU and two mitigation scenarios) for the power system expansion over the period 2008-2025. The dynamics of the expansion is optimized in order to meet the electricity demand with minimum emissions and minimum total costs (capital investments, fuel and O&M costs).

The BAU scenario assumes that the expansion of the power system is based on the thermal power plants fuelled by domestic lignite. In the first mitigation scenario two gas power plants with combined cycle are planned to replace some of the lignite-based capacities. The second mitigation scenario, besides the gas power plants, assumes reduction of the electricity consumption related to the large industrial consumers and increased share of the new renewables (small hydro and wind). Detailed calculations of the GHG emissions are made for the three scenarios. The comparison between 2025- and 2008- emissions shows that the relative increase of 78% in the case of BAU, is reduced to 41% by the first mitigation scenario, and furthermore to 14% by the second mitigation scenario.

SDEWES.2009.252

## **Interaction Between Australian Carbon Allowance and Energy Prices - an Empirical Analysis**

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### **ABSTRACT**

The overriding aim of carbon trading is to encourage the reduction of greenhouse gas emissions. An effective carbon trading scheme should reward the production of power through green sources such as hydro and wind energy and penalise the continuation of power produced by the higher emitting sources such as coal. Therefore, one could expect to find a significant effect of carbon allowance prices also on Australian electricity and gas markets. This paper investigates the interaction between carbon permit prices of two major Australian carbon trading schemes, the NSW Greenhouse Gas Abatement Scheme (GGAS) and the Mandatory Renewable Energy Target Scheme (MRET) and electricity and gas prices using a structural cointegrated VAR model. The empirical analysis does not suggest a significant effect of carbon prices on the considered energy markets in Australia. Our results can be interpreted with respect to the success of the current abatement schemes and are further of great interest for the design and implications of an effective national trading scheme to be introduced in 2010 by the current Federal Government.

## Hydrogen and Fuel Cells I

SDEWES.2009.153

### **Reduced Model of Proton Exchange Membrane (pem) Fuel Cell System for Vehicle Propulsion Systems**

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#### ABSTRACT

Nowadays fuel cell shows an excellent potential as alternative electric power source. The use of this clean power source mainly focuses on public transport (buses, trains and undergrounds), where the fuel cell is the main power generation system.

In contrast to internal combustion engines, fuel cell systems do not perform an intermediate conversion into thermal energy and from that to mechanical energy, so the efficiency of a fuel cell is not limited by the Carnot efficiency. It converts the chemical energy of fuel directly into electric energy and efficiencies of above 80% at normal operating conditions can be achieved. Among all types, proton exchange membrane (PEM) fuel cell is the best option to be used in public transport due to their high power density, specific power, low operating temperature, longevity, efficiency, good dynamic behavior and the ability to rapidly adjust to changes in power demand.

PEM fuel cell consists of two electrodes, an anode side and a cathode side, separated by a membrane. The membrane has exclusive proton permeability and is thus used to strip electrons from hydrogen atoms on the anode side to drive the load. The protons which flow through the membrane then react with oxygen to generate water on the cathode side and complete the electrical circuit.

This paper proposes a reduced model of a PEM fuel cell system for application in vehicle propulsion systems, which is evaluated by comparing with a complete model.

The complete model includes a detailed dynamic model of the main components of fuel cell system, such as described in Pukrushpan et al . This model is composed of:

- 1) A compressor with a DC motor controls the incoming air (oxygen) to the cathode.
- 2) Four manifolds (two supply and two return manifolds) which keep a stable gas flow.
- 3) An humidifier which injects water into the membrane avoiding the loss of membrane properties.
- 4) An air cooler maintains the fuel in an optimum operating temperature, normally around 50°C and 100°C.

5) A high pressure tank which provides the hydrogen to be used in the fuel cell.

The fuel cell model is completed with an electrochemical model to calculate the fuel cell output voltage, which requires the effective partial pressures of the electrodes to be determined. The partial pressures of anode and cathode have been calculated from the mass conservation and ideal gas law. On the other hand, the fuel cell output voltage has been obtained from the sum of the Nernst's voltage, the activation voltage drop, the ohmic voltage drop and the concentration voltage drop, where all the voltage drops are function of the current density.

Applying some simplifications, a reduced model of PEM fuel cell can be obtained. In this work, the following simplifications have been done:

- 1) The compressor is modelled by a first order system in order to approximate its dynamic response.
- 2) Assuming that inlet oxygen and hydrogen coming respectively from compressor and tank present a stable mass flow, the supply manifolds can be eliminated.
- 3) Return manifolds have been removed since the outlet flow of any gas is considered to be proportional to its partial pressure inside the channel.
- 4) The humidifier and air cooler are considered ideal so that the fuel cell operates at optimum temperature (80°C) and with constant relative humidity.

The proposed reduced model of PEM fuel cell system has been evaluated in its application in a vehicle propulsion system by means of simulations, where response of this reduced model is compared with that of complete model. Static and dynamic simulations have been performed.

In the static simulation, the polarization curve of fuel cell is obtained from the described models, where voltage versus current density is represented. In this case, the simulation results obtained from complete and reduced models are similar enough.

In addition, the reduced model is tested under dynamic simulations, where the fuel cell system is demanded to follow the dynamic work cycle of a public transport vehicle. The dynamic responses of both models also show similar results, with an important reduction of computation time in case of the reduced model.

Therefore, it can be concluded the validity of proposed reduced model in order to represent the behavior of a fuel cell for its application in a vehicle propulsion system.

SDEWES.2009.048

## **The Main Aspects of Reactants Selection for Solar Hydrogen Production from Water Via Thermal Chemical Redox Cycles**

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### **ABSTRACT**

A useful implementation of concentrated solar energy is thermal chemical redox cycles for hydrogen production from water using different metals. Such cycles usually consist of two steps: metal hydrolysis followed by metal oxide reduction or thermal decomposition.

The paper describes the main aspects of reactants selection ensuring effective reliable and safe operation of reactors.

Experimental results and thermodynamic analysis are presented for different elements such as boron, magnesium, zinc, tin and cadmium. It is shown that element, which can satisfy all optimal requirements for hydrolysis and reduction steps, does not exist and a compromise is inevitable. Usually, as oxidation is done easier, it is more difficult to execute the reduction, so successful hydrolysis is implemented with more difficult reduction step and vice versa.

The elements with lower molecular weight (magnesium) and also higher valency (boron) demonstrate excellent hydrogen productivity per gram of reactant. However their oxides reduction is difficult and can require multi-step. Zinc micron size powder hydrolysis demonstrates 90% conversion and good kinetic. Its reduction chemistry is simple and can be realized in two ways: carboreduction using bio carbon (charcoal) at acceptable temperature level of about 1100°C with 85-90% conversion, or direct thermal splitting, which runs at temperature above 1700-1800°C, does not demonstrates high conversion but is free of CO<sub>2</sub>. Tin oxide splitting requires temperature above 3000°C, but carboreduction with charcoal leads to full conversion with fast kinetic at temperature below 900°C. This can provide prolonged and effective exploitation of chemical reactor. Tin hydrolysis process is less productive and significant slower than hydrolysis of boron, magnesium and zinc because of its low exothermic heat, high molecular weight and back reaction occurring at relatively low temperature that suppresses hydrolysis kinetic with temperature increase. But in spite of these difficulties, tin hydrolysis can reach 90% conversion during 2 hours in batch reactor with temperature increase up to 550°C at normal pressure. Comparing with other metals, CdO splitting can be realized at relatively lower temperature of 1400-1500°C and its charcoal reduction is successfully performed at temperatures below 950°C. The main problem of Cd based redox cycle is the hydrolysis step. Besides disadvantages inherent to tin hydrolysis, cadmium has high vapor pressure at temperature above melting point (321°C). All this leads to very low productivity, low conversion and significant metal losses during the hydrolysis step. The single way to

suppress vaporization and back reaction is raising pressure up to 20-30 bar or more with significant excess of water vapor that complicates the hydrolysis reactor construction taking into account preheating temperature to the level of 500-600°C. Safety issue is also associated with the cadmium cycle.

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## **Numerical Simulation of Intermediate-temperature Direct-internal-reforming Planar SOFC**

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### **ABSTRACT**

A numerical model for an anode supported intermediate-temperature direct-internal-reforming planar SOFC is developed. It applies the volume averaging method to the flow passages in SOFC assuming that porous materials are inserted in the passages as current collectors. This treatment reduces the computational time and cost by avoiding a full 3D simulation, while keeping the capability to solve the flow and pressure fields in the streamwise and spanwise directions. In the proposed model, quasi-three-dimensional multi-component gas flow fields, temperature field and the electric potential/current fields are simultaneously solved. Steam reforming reaction of methane, water shift reaction and the electro-chemical reactions of hydrogen and carbon monoxide are taken into account. It is found that the local temperature and local current density distributions can be controlled by tuning the pre-reforming rate. Even a small amount of heat loss to the sidewall causes significant non-uniformity of the flow and thermal fields in the spanwise direction.



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## **Hydrogen from The Aqueous Fraction of Biomass Pyrolysis Liquids by Catalytic Steam Reforming in Fluidized Bed**

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### **ABSTRACT**

Catalytic steam reforming of biomass pyrolysis liquids (bio-oil) is a promising process in order to produce hydrogen in a sustainable environmentally friendly way that can improve the utilisation of the local resources (natural sources or wastes). The aqueous fraction of bio-oil is catalytically steam reformed at 650 °C and atmospheric pressure in a fluidized bed reactor. Research nickel based catalysts some of them modified with calcium or magnesium with an adequate mechanical strength are tested. The results will show the effect of the different catalysts on gas yields, coke formation and carbon conversion.

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## **Hydrogen in Zr and Ti Based Amorphous Alloys**

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### **ABSTRACT**

Zirconium and Titanium based metallic glasses exhibit high thermal stability corresponding to a wide undercooled liquid region. Amorphous alloys, containing Ti and Zr especially, have been investigated with a view to hydrogen storage since they are not pulverized upon absorption and desorption of hydrogen and, in addition, have an improved hydrogen absorption rate as compared with their crystalline counterparts. The combination of early and late transition metals makes these alloys very interesting regarding their interaction with hydrogen.

Amorphous  $\text{Cu}_{33}\text{Ti}_{67}$ ,  $\text{Cu}_{33}\text{Zr}_{67}$  and  $\text{Ni}_{33}\text{Ti}_{67}$  ribbons were prepared by melt spinning and their structure before and after hydriding was checked by X-ray diffraction. Cathodic hydrogenation was carried out in a 1:1 glycerin: phosphoric acid electrolyte at 25°C and current density of  $i = 5\text{mA/cm}^2$ . Formation of  $\text{TiH}_2$  was observed for all Ti based alloys after electrochemical hydrogenation at room temperature. Hydrogen desorption as well as the influence of hydrogen on the crystallization were studied by differential scanning calorimetry under argon atmosphere. At higher hydrogen concentrations the thermal stability of the glasses was strongly reduced, for some alloys with about 250 K. The hydrogen absorbed into the alloys forms a solid solution into the amorphous metal matrix and part of it is in the form of hydrides. To determine the amount of the absorbed hydrogen and to obtain information about the H-desorption rate a thermogravimetric analysis (TG) of the H-charged ribbons at constant heating rate was carried out.

## Biomass, Biogas And Biofuels: Conversion Processes I

SDEWES.2009.330

### Enhancement of Biogas Production from Olive Mill Wastewater: Influence of Biomass Selection

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#### ABSTRACT

Olive mill wastewater (OMW) is the effluent generated by olive oil industries, mainly produced in the Mediterranean areas. It holds a high energetic potential but several difficulties related to the disposal and biological treatment of OMW are known: seasonal production, high COD, acid pH values (4-5), unfavourable C/N ratio (nitrogen lacking), and high content of phenolic and lipidic compounds that are resistant to biological degradation.

This work aims at select a suitable inoculum to accelerate the start-up and to enhance biogas production from the OMW treatment. Two anaerobic sludges were tested in toxicity and biodegradability batch experiments: biomass acclimated to oleate (BAO) and biomass non-acclimated (BNA). In the methanogenic toxicity tests, the OMW concentration ranged from 5 to 50 gCOD/L. Acetate was added as co-substrate, in order to evaluate the influence of OMW concentration on the acetoclastic activity. Biodegradability tests were performed with OMW concentrations of 5 and 10 gCOD L<sup>-1</sup>.

The results show that resistance to OMW toxicity was higher for the BAO than for the BNA. In the presence of OMW, the BNA was inhibited for all the concentrations tested, whereas for the BAO no inhibition occurred at 5 and 10 gCOD L<sup>-1</sup> and even at 25 gCOD L<sup>-1</sup> both substrates (acetate + OMW) were degraded.

The use of an acclimated microbial consortium is a promising strategy to accelerate the start-up of the digestion process and to improve the overall anaerobic treatment of a real oily wastewater such as OMW with simultaneous bioenergy production (biogas).

SDEWES.2009.436

## **The Production of Biodiesel from Waste Frying Oils: Effect of Catalyst**

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### **ABSTRACT**

Increasing concerns regarding environmental impacts, the soaring price of petroleum products together with the depletion of fossil fuels have prompted considerable research to identify alternative fuel sources. Biofuel has recently attracted huge attention in different countries all over the world because of its renewability, better gas emissions and its biodegradability. Biodiesel is superior to conventional diesel in terms of its sulphur content, aromatic content and flash point. It is essentially sulphur free and non-aromatic while conventional diesel can contain up to 500 ppm SO<sub>2</sub> and 20–40 wt% aromatic compounds. These advantages could be a key solution to reduce the problem of urban pollution since transport sector is an important contributor of the total gas emissions.

In this study, the effects of catalyst on biodiesel production from waste frying oil (sunflower oil) production via alkaline catalyzed transesterification with various catalysts (NaOH, KOH, NaOCH<sub>3</sub>, and KOCH<sub>3</sub>) were studied. In all of the experiments, the following optimized conditions (methanol: oil molar ratio: 7.5:1; agitation intensity: 600 rpm; catalyst wt. %: 0.5; and reaction temperature: 50°C; rxn time: 30 min.) were employed. The resultant methyl esters were characterized and a number of important fuel properties were determined and compared.

SDEWES.2009.448

## **Enhancing Wastewater Degradation and Biogas Production by Intermittent Operation of Uasb Reactors**

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### **ABSTRACT**

The present work establishes intermittent operation of UASB reactors as a novel form of enhancing the anaerobic degradation of complex wastewaters and the conversion to usable biogas. It has been shown that in the anaerobic treatment of complex fat containing effluents the initial removal of organic matter is mainly done by adsorption mechanisms. This results in heavy accumulation of organic matter in the sludge bed hindering reactor performance. A period without feeding or a stabilization period would be important to reverse this process and degrade the accumulated organic matter to usable methane. Intermittent operation consists of interrupting reactor feeding during certain periods of time. During this feedless or stabilization periods, time is given for the biological degradation to catch up with the adsorption phenomenon, thus eliminating or reducing the accumulation of organic matter in the sludge bed. Results show that the methanization efficiency obtained in intermittent UASB reactors is around 16% higher than the observed in continuous systems confirming a higher biological degradation of the substrate in intermittent systems. It has been suggested that in the absence of feed, and after having degraded the easily degradable substrates, the bacteria are forced to degrade the complex substrates like proteins and fats adsorbed onto the biomass particles. So the stabilization period causes a forced adaptation of the biomass towards the degradation of the complex substrates, ultimately resulting in a higher production of energy rich biogas. Results of morphological analyses of the biomass developed in intermittent and continuous UASB reactors showed marked differences in the type of microorganisms present and in their aggregation status. The sludge from the continuous reactor was mainly constituted of cocci bacteria, loose or grouped in small aggregates and in long chains. The sludge from the intermittent reactor shows the predominance of rod-like bacteria, loose or grouped in small aggregates and also the presence of small cocci chains. In order to gain a deeper knowledge on the microbial species thriving inside the UASB reactors, we have designed primer pairs targeting the 16S rRNA genes for the more representative metabolic groups. Results obtained on the fluctuations observed in the

microbial populations associated with the intermittent and continuous modes of operation of the UASB reactors, revealed by sequence analysis of the cloned amplimers obtained by PCR using as template the total DNA extracted from reactors' samples, will be presented and discussed. As a conclusion, this work confirms intermittent operation as a new way to enhance the valorization of complex wastewaters converting them to renewable energy sources by means of a forced adaptation of the biological community towards the degradation of complex substrates.

SDEWES.2009.412

## **Improving Biomass Stove with a Thermoelectric Generator**

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### **ABSTRACT**

In developing countries biomass is too often burnt through open fire or rudimentary stoves. Even if Biomass is a CO<sub>2</sub>-neutral renewable source of energy, traditional stoves are characterized by low efficiency which results in inefficient use of scarce fuel-wood supplies. In developed countries, wood is considered as a sustainable fuel source, because the forestry industry currently plants more trees than it chops down. On the contrary, in many developing countries forests are scarce or dwindling and it becomes a necessity to save wood fuel. Open fire stoves are also known to lead to high emissions of health damaging air pollutants and smoke is highly linked to acute respiratory infection (ARI). Replacing traditional open fire stoves with improved ones is an important challenge.

The Non Governmental Organisation 'Plan  te Bois' is developing energy-efficient multifunction (cooking and hot water) mud stove based on traditional stove designs. The use of a fan increases the ratio air to fuel and allows to achieve a complete combustion. Smoke can also be extracted with a horizontal pipe avoiding the building of a vertical chimney. For zones with unreliable electricity supply powering the fan is a problem. A thermoelectric generator using commercial thermoelectric modules (Bismuth Telluride) has been developed in our laboratory for powering the fan.

In a first part the paper presents the ThermoElectric power Generator for Biomass Stoves (TEGBioS) and in a second part an electric convertor for the storage of this electricity is described with the possibility of adding new functions (light, radio ...) to the stove

SDEWES.2009.437

## **Biodiesel Production from Castor Oil Using Full Factorial Design**

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### **ABSTRACT**

In this study optimization of biodiesel production from castor oil using full factorial design was investigated. The biodiesel was produced by alkaline-catalyzed transesterification process, which was designed according to the 23 full factorial central composite design (CCD). The effect of temperature, methanol/oil molar ratio and catalyst concentration were studied. Different purification methods applied to the product after transesterification reaction. Temperature and catalyst concentration were more effective on biodiesel conversion than methanol/oil molar ratio. Second-order model were obtained to predict biodiesel yield as a function of these variables. According to the experimental results this process gave an average yield of biodiesel more than 90%.



SDEWES.2009.319

## **Olive Mill Wastewater As an Energy Source: Anaerobic Digestion in a Hybrid Reactor**

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### **ABSTRACT**

Olive mill wastewater (OMW) is generated from olive oil industries, which activity has a great economic and social importance in the olive growing countries. OMW is one of the most polluting agro-industrial effluents. Containing chemical oxygen demand (COD) concentrations up to  $200 \text{ kg m}^{-3}$ , it is a very important energy source. Anaerobic digestion provides the conversion of the chemical energy of effluent into a renewable energy (biogas). However, OMW has a low pH (4-5) and several inhibitory substances as phenolic compounds that cause damages in the anaerobic microbial consortium.

An anaerobic hybrid reactor has been working for 200 days to digest the raw OMW in order to assess its organic removal capacity, especially with respect to phenolic compounds (33% of its total volume). Hybrid reactor is an up-flow packed bed unit where the bed material only occupies the upper section of column. The characterization of the hybrid profile under different operational conditions was exploited to study its functioning. Different parameters have been used (phenolic compounds, total and soluble COD, volatile fatty acids and pH) to evaluate the role of the different sections of column and its contribution to the influent removal.

The results show that the hybrid reactor is an interesting choice for the treatment and valorization of OMW since the greatest amount of influent organic matter is converted into methane. Values of COD removal up to 75-80% have been registered. Methane productivity improvement was observed along of the loading rates indicating that the tested hybrid can be advantageously applied. Operating a plant of  $1000 \text{ m}^3$ , a potential of 0.7-0.8 GWh (power) and 1 GWh (heat) is available to be used in the mill during the olive campaign.

## Greenhouse Gas Emissions, Impacts and Countermeasures III

SDEWES.2009.380

### **Hydropower Generation and Greenhouse Gas Emissions in Review**

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#### **ABSTRACT**

The hydro reservoirs like as others human induced projects have several effects on the environment. These effects are very well studied over two last decades. One of most important effects of dam impoundment is potential changes in the movement of water by flowing much slower than the original river. This new condition favors the establishment of phytoplankton and nutrients increase in which methanogenesis replaces the oxidative water generating anaerobic conditions.

Recent research from the end of 90's point out the problem of hydroelectric dams that emits greenhouse gases but important questions regarding this debate is uncertain until now.

Hydropower reservoirs like as other natural water bodies have intense biota, since microorganisms to aquatic vertebrates. The microorganism (bacteria) decomposes the organic matter producing biogenic gases under water.

Some of these biogenic gases are effective in terms of global warming such as methane, carbon dioxide and nitrous oxide. GHG emission from hydro reservoir is a subject of extreme strategic importance and comparison with other types of electric generation like as thermo power should be required.

To determine accurately the net emissions caused by hydro reservoir creation is required significant improvement of carbon budgets studies on different representatives' hydro reservoirs at tropical, boreal, arid, semi arid and temperate climate.

To promote comparisons, the emissions by the equivalent thermo power plants must be calculated and characterized as generating the same annual amount of energy as each power dams, burning different fuels and with technology efficiency levels that vary from steam turbines to coal, fuel oil / natural gas turbines and combined cycle.

This paper brings the state-of-the-art regarding this subject and some proposals for future studies.

SDEWES.2009.391

## **Biochar As a Viable Carbon Sequestration Option**

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### **ABSTRACT**

Current trend in atmospheric CO<sub>2</sub> concentration calls for dramatic reduction in anthropogenic CO<sub>2</sub> emissions in order to avoid runaway scenario of potentially catastrophic temperature and sea level rise. The annual mean CO<sub>2</sub> growth rate was significantly higher for the period from 2000 to 2005 ( $4.1 \pm 0.1$  Pg/yr), compared with the flux in the 1990s ( $3.2 \pm 0.1$  Pg/yr), even though 45% of the antropogenic emissions are being naturally sequestered by terrestrial and oceanic systems. In addition to curbing the fossil fuel and cement production CO<sub>2</sub> emissions, several strategies for deliberate CO<sub>2</sub> sequestering are being proposed: pumping CO<sub>2</sub> into underground reservoirs; injecting CO<sub>2</sub> into chemically reactive rock mases, even dead wood burial. Biochar, or black carbon, as it is sometimes called, is rapidly gaining its place as a viable option in permanent (on the scale of several millennia) carbon storage, while its other benefits emerge from various research directions: soil fertility increase, adsorbent for other nutrients in the soil, protecting runoff, a potential habitat for microorganism proliferation, water reservoir, potential barrier to CH<sub>4</sub> and N<sub>2</sub>O release from soil. Various combined benefits to soil quality have been documented as large pockets of permanently fertile soil in the Amazonian basin, known locally as *terra preta* ("dark earth" in Portuguese). While our knowledge of the role of black carbon in soil is still rudimentary, most what we know today points to positive influence that it exerts on soil quality. The International Biochar Initiative, est. 2006 (<http://www.biochar-international.org/>) and regional biochar groups, promote the research, development, demonstration, deployment and commercialization of the biochar technology. In addition, they serve as advocacy groups for recognition of biochar as carbon sequestration venue that deserves proper carbon credits.

SDEWES.2009.468

## **Mitigation of Environmental Issues Via Kyoto Protocol: a Realistic Or Foolish Approach**

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### **ABSTRACT**

Global warming and environmental pollution are currently two of the most serious threats to human civilization and sustainable development. For instance, phenomenon such as shrinking of North Pole iceberg, flood and drought in unprecedented locations and unnatural heat waves are some of the evidences that global warming and environmental pollution are occurring around the globe at an alarming rate. Hence, the establishment of Kyoto Protocol in 1997 and subsequently its enforcement in 2005 was a timely call for a concerted effort by all countries towards mitigating environmental issues by reducing CO<sub>2</sub> emission below 1990 level. However, the mechanisms proposed in Kyoto Protocol to achieve its target have some weaknesses which limit its enforcement and achievement towards the goals. Consequently, this paper will discuss the mechanisms of Kyoto Protocol and subsequently highlights some of the weaknesses that were identified. Apart from that, a few recommendations/policies were proposed as well to overcome the incongruities of the current Kyoto Protocol mechanisms.

SDEWES.2009.561

## **Renewable Energy Sources and Their Potential Role in Mitigation of Climate Changes and As a Sustainable Development Driver in Bosnia and Herzegovina**

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### **ABSTRACT**

Bosnia and Herzegovina have significant physical potential regarding to renewable energy sources. Hydro, biomass, geothermal, wind and solar potential can play important role in the whole state economy. Bosnia and Herzegovina is Non-Annex I country according to UNFCCC and according to that it is obligated to participate in the global efforts in order to reduce green house gases emission. This paper gives some analysis of the physical, technological, economic, and market potential of renewable energy sources in Bosnia and Herzegovina and their potential role in mitigation of climate changes. Paper also gives the analysis of the potential connections between renewable energy sources and sustainable development of the B&H's economy, taking in to consideration specific political structure of the state. Bosnia and Herzegovina is consisting from two entities: Republic of Srpska and Federation of Bosnia and Herzegovina and Brcko District, energy sector and climate changes mitigation measures are under their jurisdiction. According to that some of this paper results can be useful for the improvement of entity and state strategies with the final aim to place renewable energy sources on the right position, as some of the major economy drivers, not only in Bosnia and Herzegovina, but in whole region.

## Hydrogen and Fuel Cells II

SDEWES.2009.087

### Exergoenvironmental Analysis of a Steam Methane Reforming Process for Hydrogen Production

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#### ABSTRACT

Steam methane reforming (SRM) is one of the most promising processes for hydrogen production. Several studies have demonstrated its advantages from the economic viewpoint. Nowadays process development is based on technical and economical aspects; however, in the near future, the environmental impact will play a significant role in the design of such processes.

In this work, a SRM process is studied from an environmental viewpoint using the exergoenvironmental methodology. The latter represents a combination of an exergy analysis with a comprehensive environmental assessment method - such as Life Cycle Analysis (LCA) - when the principles of exergoeconomic analysis are employed.

The SRM process is characterized by a high energetic and exergetic efficiency. The chemical reactor units are the most important plant components from the exergoenvironmental point of view because in these components the highest environmental impact is formed. According to our results, some heat exchangers and the hydrogen separation membrane unit are associated with a high component-related environmental impact, and also with a relatively high potential for improvement. However, the environmental impact associated with the reformer or the combustion chamber is mainly due to exergy destruction.

Therefore, a reduction of the environmental impact of the overall system can be achieved by reducing the material consumption for some heat exchangers and for the

hydrogen separation membrane unit as well as by increasing the exergy efficiency of the combustion chamber and the reformer, even though this would increase the component related environmental impact associated with these components.

SDEWES.2009.156

## **Hydrogen from Biological Sources As a Carrier of Energy**

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### **ABSTRACT**

According to Intergovernmental Panel on Climate Change our excessive dependence on fossil fuels is one of the most important reasons for current interconnected crises of energy and climate. H<sub>2</sub> as a source of energy could solve this problem, if renewable and environmentally friendly generation of large quantities of H<sub>2</sub> gas is possible.

We estimated economic viability of biological production of hydrogen, which can be produced in a bioreactor based on either algae or fermentative bacteria. Hydrogen production from organical substrate remains coming from microbiological wastewater treatment in bioreactors is a very promising process. Advantage of the production by bacteria is that bacteria do not need the sunlight for the conversion, there is not much space needed because the bioreactors are smaller. Algal bioreactors have the added economic benefit because they are relatively cheap and because they use photosynthesis to extract carbon dioxide (CO<sub>2</sub>) from the atmosphere and so are of interest in terms of global carbon trading. The biomass generated can itself be used as a fuel for electricity generation. The Wild Type (wt) and high H<sub>2</sub> producing mutants of *Chlamydomonas reinhardtii*, which produce H<sub>2</sub> at rates 6-15 times that of the wt, are commonly used, because its genome is known and genetic manipulation processes are well developed.

Both wastewater treatment by fermentative bacteria or extraction of CO<sub>2</sub> from the atmosphere by algae as well as production and usage of hydrogen as fuel are promising technologies, which would result in reduction of the amount of CO<sub>2</sub> in the atmosphere. When efficiency of bioreactors will improve significantly, large scale applications will become economically viable.



SDEWES.2009.555

## **Optimization of a MCFC Power System Coupled with Hydrogen Production**

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### **ABSTRACT**

In this paper, a biogas fuelled power generation system is considered. The system is based on a molten carbonate fuel cell stack for electricity generation. This is integrated with a micro gas turbine, an internal reformer and a PSA for hydrogen production.

The aim of this work is the multi-objective optimisation of the system plant considering thermodynamic and techno-economic objective functions as the electrical efficiency, the net power, the unit cost of electricity and the plant lifetime.

A model of the plant is built and coupled with a tool for the design of the heat transfer network. The system is then optimized by operating on the main design parameters as well as on the heat transfer network configuration. Typical operating conditions of the system along the plant lifetime are considered in the formulation of the objective function. This is achieved by considering variations in the ambient temperature and in the biogas composition, as well as time degradation in the fuel cell performances.

SDEWES.2009.245

## **Energy Production Through the Conjunction of Agro-residues Thermochemical Conversion with Solid Oxide Fuel Cells (SOFC)**

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### **ABSTRACT**

Abstract. The production of energy and materials by recycling alternative sources and its impact on climate change are among the main strategic tools implicated in the sustainable development of our society. Green energy, green biofuels and environmental high added materials production in parallel to waste recycling could be a principal contributor in economic development of a developing country based in agriculture activity and waste utilisation.

Accordingly, numerous types of biomass and wastes contribute towards the production of energy and materials in parallel with reduction in the use of fossil fuels by means of biological, chemical and thermal processes. Further to the above, in modern integrated waste management scenarios the waste-to-energy process allows the cycle to be closed.

Biomass is a clean and available energy source, since it contributes to net CO<sub>2</sub> emissions to the atmosphere and will play an important role in a future sustainable energy supply. Fuels issued from lignocellulose biomass are the most attractive among bio-fuels, as they present better projected economics; their feedstock requires less additional energy for growth and harvest and can also be grown under different climatic circumstances in contrast to annual crops that require good-quality land.

Among all the thermochemical processes, pyrolysis, is one form of energy recovery process, which has the potential to generate char, oil and gas product. Pyrolysis is determined as the thermal decomposition of the organic matter either with total absence of an oxidant, either with minimum feed in order to avoid volatilization. The applied temperature range for pyrolysis process is relatively low (300-700°C) in comparison to gasification (700-1200°C). Pyrolysis temperature has the most significant effect-followed by pyrolysis heating rate, the carrier gas flow rate and then finally the pyrolysis residence time in products distribution according to scientific bibliography. Increased temperatures lead to a decreased yield of solid (char) and an increased yield of liquid (tar) and gaseous product.

The liquid product of pyrolysis could be used for biodiesel production while the gaseous product could be exploited for energy production. Ultimately, hydrogen may offer the best perspective; but requires breakthroughs in hydrogen storage technology to tick the balance

The remaining solid (char) of the thermal treatment of biomass is an attractive by-product, with applications including production of activated carbons, useful in air pollution control as well as wastewater treatment. Agricultural by-products and used tyres have proved to be promising raw materials for the production of activated carbons due to their availability at a low (and most of the times zero) price, their high carbon content and low ash

Despite the growing interest in the use of these technologies, in many countries their implementation remains limited, chiefly due to reasons other than those of a technical and economical nature

The aim of the presentation is to focus on the advances made in the development of pyrolysis technologies for energy, fuels and material recovery from biomass and waste and to encourage discussion on relevant aspects.

## Biomass, Biogas and Biofuels: Potentials and Limitations II

SDEWES.2009.467

### Can Sunflower Provide Biofuel for Inland Demand? An Integrated Assessment of Sustainability At Regional Scale

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#### ABSTRACT

Biofuels are often considered a key solution to reduce reliance on fossil oil, greenhouse gas emissions and to meet rural development goals. However, recent studies have demonstrated that biofuels sustainability is not always assured and some doubts have been raised about energy benefits of large-scale biofuels production and about the risk of increasing competition with food crops. Therefore, this study aimed to evaluate the sustainability of the supply chain of biodiesel from sunflower at detailed scale (1x1 Km) and the exploitation level of arable land under different scenarios. The Tuscany region (Italy) was chosen in order to highlight the environmental constraints which affect biofuel production in Mediterranean areas, and because of the interest shown by local authorities in developing a biofuel regional plan. The supply chain sustainability was assessed considering simulated crop yield, energy efficiency, CO<sub>2</sub> emissions and land requirement. The analysis was performed by developing a GIS framework which integrated 1) a sunflower growth model (EPIC), 2) a soil database (ESBD JRC), 3) 20-years weather dataset (ARSIA), and 4) a land cover database (CORINE). In order to calculate the overall energy and carbon budgets a set of assumptions about all activities involved in production and delivery of biofuel were identified. These assumptions were defined considering both standard management practices of local farmers and literature references. Land requirement assessment was performed under different scenarios based on 1) road transport diesel demand, 2) diesel for agricultural operations and 3) EU biofuels targets for 2010 and 2020.

Energy and carbon budgets permitted to identify suitable areas for sustainable production at detailed scale. Moreover, the land requirement assessment allowed to evaluate the level of competition with food crops for arable land under the different scenarios. The growth model along with the spatial analysis permitted to estimate the biodiesel potential based on main environmental constraints at different locations. Furthermore, GIS provided clear information for decision makers interested to evaluate

the prospect of developing local biodiesel supply chains, considering both the diesel inland demand and the regional planning targets.

SDEWES.2009.295

## **Potential of Waste Palm Cooking Oil in Catalyst-free Biodiesel Production**

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### **ABSTRACT**

Disposal of waste palm cooking oil (WPCO) via environmental-friendly route is of major importance in the quest towards sustainable development. In this study, WPCO is utilized as the source of triglycerides to produce biodiesel, instead of refined vegetable oils. Since WPCO is relatively cheaper compared to high quality vegetable oils, the cost of biodiesel produced is lower as well. WPCO consists of several impurities such as water and free fatty acids which limit its application in catalytic transesterification process due to the sensitivity of the catalysts. Consequently, catalyst-free process of supercritical alcohol was employed in this study to investigate to potential of WPCO as an economical feedstock for biodiesel production. The parameters that influence the reaction such as reaction time, temperature and molar ratio of alcohol to oil were investigated. For comparison purposes, refined palm oil (RPO) was subjected to supercritical alcohol reaction as well and it was found that the yield of WPCO is comparable with those from RPO. As for conclusion, this study has shown that WPCO is an economical and practical source of 'green' biofuel.

SDEWES.2009.384

## **Energy and Food Security: Peru and Ecuador Case Study**

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### **ABSTRACT**

Efficient food supply chains are a defining feature of climate-proof food systems, yet their high dependence on energy is increasingly considered as a menace to Food Security. Many food insecure countries are also energy insecure and rely on import of both food and energy. Peru and Ecuador are two case/study countries that host a large population who has no access to modern energy services and is food insecure.

Energy is fundamental to all four dimensions of Food Security: availability, access, utilization and stability. The production, transformation and transport of food require relevant amounts of exo-somatic energy; refrigeration and cooking are also costly but fundamental.

Centralized large scale generation provided affordable energy services to many but failed to include the poorest and most remote communities. Renewable energy locally sourced such as solar, wind, hydro, biomass will play a very important role in boosting development in energy and food insecure areas (rural or peri-urban). Distributed generation is key to secure energy supply from Market and Climate shocks, improving opportunities for development and resilience of food systems.

SDEWES.2009.459

## **Development of Utilization of Bio-energy Sources in Slovenia**

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### **ABSTRACT**

Utilization of renewable energy sources is one of the main EU measures to reduce greenhouse gases emissions and decrease energy dependency. The main strategic goals of EU and Slovenian energy strategy are reduction of the emissions of greenhouses gases, increase of the share and electricity production from renewable energy sources (RES) and decrease of energy dependency. The overall targets of the EU climate and energy package "20-20-20" to 2020 are 20% increase in energy efficiency, 20% reduction in greenhouse gas (GHG) emissions, 20% share of renewable energy sources in overall EU energy consumption and 10% biofuel component in vehicle fuel by 2020. The individual targets for each Member State have to be determined as fairly as possible. The obligation of Slovenia is to increase electricity production from RES to 33.6% of total electricity consumption in 2010. The share of RES in 2007 was 10.1% in energy balance and 15.1% in final energy consumption. The main bioenergy sources in Slovenia are wood biomass and biogas. Wood biomass resources are very important domestic energy sources in Slovenia, besides coal and hydro energy. The energy utilization of biogas from anaerobic digestion manure, agricultural wastes, agricultural silage, organic wastes from kitchens, other organic wastes, sewage and landfill gas is increasing rapidly. The paper gives a clear picture of the utilization and potential of bioenergy sources. An action plan for increasing utilization of wood biomass and utilization of biogas in agriculture is needed. The energy policy, financing supporting mechanisms and other energy policy in Slovenia are described in the paper.



## Renewable Energy Planning and Implementation I

SDEWES.2009.155

### **Renewable Energy in Danish Municipalities - an Evaluation of The Planning Framework**

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#### **ABSTRACT**

The transition of the energy sector towards more sustainable systems of energy production and consumption poses a number of technological, socio-economic and political challenges that require innovative long-term approaches within the current energy planning system. While certain renewable technologies such as wind power, biomass and solar are sometimes considered as mature as incumbent technologies, their actual large-scale implementation requires planning approaches different from the traditional ones. The initiatives and involvement of local and regional actors are needed to ensure the emergence of such decentralised technologies and energy systems on a wider scale. In this paper we examine to what extent the existing planning framework in Denmark can provide for a large-scale penetration of renewable energy solutions in, for instance, the municipalities. Taking wind power as an example we explore the potentials of current policies and frameworks in the form of support and certification schemes and distribution of responsibilities regarding spatial planning, impact assessment and ownership. The paper concludes by recommending a number of changes that would lead to an alternative set up of the planning system and possibly to more flexible, integrated and decentralised forms of energy planning.

SDEWES.2009.287

## **Increasing the Penetration of Renewable Energy Resources in S. Vicente, Cape Verde**

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### **ABSTRACT**

In general, most islands depend mainly on the importation of fossil fuels for energy production. On the other hand, most of the islands present a considerable potential in renewable energies. Several initiatives have been carried out in some islands, mostly in Europe, for the use of this potential in the production of electricity and fresh water (usually very scarce in islands).

Due to high energy costs, the islands present an excellent experimentation platform for the introduction of new energy technologies. Some islands are trying to become renewable islands, to satisfy their energy demand mainly or entirely from indigenous and renewable sources, thus increasing the security of supply and employment opportunities, without necessarily increasing the costs.

Islands that have energy sources, such as hydro or geothermal energy, can easily integrate them into the power system, but those with mainly intermittent renewable energy sources (wind, solar) have to tackle the need of energy storage. Here, advanced energy planning must be used to combine different intermittent and regular sources in order to match electricity demand and assure security of supply.

The main objective of this paper is to analyse different scenarios for increasing the penetration of renewable energies in the energy system of S. Vicente Island in Cape Verde, using the H<sub>2</sub>RES model, a tool designed to simulate the integration of renewable sources and hydrogen in the energy systems of island or other isolated locations.

This island is extremely dry, and fresh water is provided to the population by sea water desalination, a very high energy intensive process. The electricity supply system is based on diesel and wind (still low penetration). S. Vicente has important wind resources that are not fully used because of its intermittent nature.

In this paper, an integrated approach is used to analyse the electricity and water supply systems in order to increase their efficiency. In the centre of the island there is a 774 meters high mountain. The present study incorporates the possibility of using reversible hydro as a storage technique to increase the penetration of renewable energy sources, using desalinated sea water.

SDEWES.2009.460

## **Evaluation of Generation Planning and Rural Electrification in Tropical Region with Decentralized Generation**

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### **ABSTRACT**

With recent development of many decentralized generations such as photovoltaic, wind power, and gas engines, options for rural electrifications have increased tremendously. In contrast to centralized generation, decentralized generation has the potential to deliver energy at high efficiency through use of exhaust heat from generation, and it can use renewable energy sources onsite to generate power. Furthermore, it could contribute in improving stability of transmission when strategically located. However, the efficiency of decentralized generation, such as combined heat and power plants and renewable energy, extremely varies depending on parameters such as operational conditions and geographical location. Additionally, the benefits from the technologies depend on the condition of current power system along with available infrastructure.

In this study an energy system model of Papua New Guinea including decentralized generation, centralized generation, and grid systems of electricity and gas are developed. For electrification of rural area option of extending grid system or installing decentralized generation are given, and being a developed country development paths under CDM are considered. Optimal energy plans focusing on the most cost effective way to electrify rural areas while keeping the emissions level low are simulated under different developing scenarios.

The results of simulations show the most cost effective way of providing a low emission energy system is by extending the power grid and advancing hydro power. Extending the power grid is found to be more economical than decentralized generation, as it allows economical generation such as coal and hydro power to supply all the demands. If the grid is not extended a reduction of emissions is possible through installation of photovoltaic, but it is only economical under high fossil fuel prices.

SDEWES.2009.385

## **Energy Independence in Islands - the Archipelago of Açores a Case Study**

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### **ABSTRACT**

Energy, lato sensu, is associated with socio-economic development of a country or region. Island economic development is the consequence of its normal endogenous economic limitations, which results from its normal paucity of natural resources and reduced qualify human resources, associated with a high level of energy dependency from fossil fuels.

The primary governmental objective in which concerns energy program, in small islands and archipelagic regions - such as in Açores - is to reduce the use of oil products utilized in the production of electricity and consequently minimize the expense associated with the importation of fossil energy as well as its environmental impact.

Renewable energy sources in Açores have been increasing, during the last decades, its representativeness in the production of electricity.

Açores Islands can be considered a real case study, on electricity production, because are in fact a very good example of how to reduce dependency and simultaneously use green energy efficiently in order to obtain sustainable development.

Last year total regional electricity production, serving about a quarter of a million habitants in all islands, was about 821.4 GWh, representing the production through renewable sources - small hydro, wind, biomass and geothermic systems - about 26.5% (217.5 GWh).

Geothermal production represents 78.3% of total renewable energy on the archipelago, while hydro and wind production corresponds, respectively, to 11.6% and 10.1%. Biomass production, in an experimental phase, does not have a significant perceptual value.

It is expect that in about three to four years, as a result of the public investment program on renewable energy sources, mainly geothermal and wind systems in several islands, the perceptual representativeness will be 40% from all total electricity production.

Besides the energetic independence of the Region, renewable production of electricity will permit annual savings (in 2008 was about 1.5 million euros) which increases considerably in periods of energy crises, such as that which has taken place during the last two years, compounded by the high volatility of fossil fuel prices.

Also as a consequence from reduced utilization of fossil products for electricity production, as a significant source of air pollution and greenhouse gas emissions, one of the main economic activity - tourism - can better contribute to the economic sustainable development of the Region.

SDEWES.2009.268

## **Human Health-related Externalities in Energy System Modelling**

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### **ABSTRACT**

This paper discusses methodology of energy system analysis, when reduction of local externalities, such as damage to human health, from energy production, is in focus. Ideally local energy externalities should be analysed by adopting the impact pathway approach of ExternE study, and follow the pollutants from their release to the personal uptake and resulting health effects. This would require inclusion of air pollution modelling and monetary valuation of the impacts into an energy system optimisation process. However, this approach involves a complex study and generalisations are needed.

The paper describes relations between energy production and resulting health damages. The way local externalities are included in the existing energy system models is identified and discussed. Only few studies include localisation aspects when internalising local externalities in energy system optimisation. The performed optimisation of the Danish energy system demonstrates the effects of including localisation aspects, when internalising health externalities into energy system planning.

SDEWES.2009.408

## **Sustainable Energy Planning on The Island of Brač**

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### **ABSTRACT**

According to the modern perception local planning is one of the key prerequisite of well-balanced, quality and sustainable development, both in energy sector and other sectors. Energy planning at local level sets up a firm basis for decentralization and security of supply; helps achieve competitiveness, rational use of energy resources and environmental protection. Islands are particular natural resources in every country, so they require special attention and care even when defining future energy system development. The island of Brač present specific case where crucial conditions for establishing sustainable energy development were created. Local authorities, energy suppliers and other local energy actors and citizens recognize importance of their involvement in creation of energy development plan of the island and its implementation in order to achieve balanced and optimizing supply from old and new conventional and renewable energy sources. Application of various integrated measures will results with sophisticated energy planning methodology applicable not only on islands level but in local communities in general.

## Measurement and Monitoring for Sustainability II

SDEWES.2009.442

### **On the Use of The Real-time Deformation Monitoring System for Improving the Safety and Economy of Significant Structures**

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#### **ABSTRACT**

The safety and vitality of publicly important structures (power plants, electric power lines, pipelines, water dams, mines...) and their impact on the environment are crucial for their operation and related good public opinion. Several recent deformation monitoring studies have proven that this kind of control is suitable for the observation of variations in structures and their vicinity.

This paper presents the use of the (Real-Time) Monitoring System in the stone-pit Lipica II, a method that is able to combine geodetic, geotechnical and meteorological sensors to match our needs of the monitoring project. In 2008, we had started to continuously monitor the movements and deformations of critical points immediately around the stone-pit. The system consists of four points; one stable/reference point and three observation points. The reference point is based on a GNSS sensor suitable for both real time kinematic and automatic post-processing operations. The observation points are based on GNSS sensors as well, and in addition, the precise inclinometers are collocated with the observation points to provide information about the stability of every single point. The reference point is used as an origin of vectors to observation points, from which the coordinates of the observation points are defined. Any kinds of change in size and/or direction of vectors signify the movements of observation points.

Numerous other modifications and variations in present monitoring are possible, including the monitoring of seismic noise, chemical air quality and radiation in general, with respect to time and position.

SDEWES.2009.523

## **Measurements of CO<sub>2</sub> Distribution in Free Atmosphere**

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### **ABSTRACT**

Considering that most of the energy is still being generated from fossil fuels, the necessity of understanding of flue gas emission and its distribution into the atmosphere relation is very important. In this paper the methodology for measurement of CO<sub>2</sub> concentration, as the reference component of the flue gas imission is shown. The measurements are being performed on 10m high masts, on two locations, in upwind and downwind side of the industrial source. The wind characteristics - speed and direction - are also being measured. The measuring system has been developed depending on the requirements for the measured quantities.



SDEWES.2009.495

## **The SnO<sub>2</sub> Solid State Gas Sensor and Changes of Some its Properties Used for NH<sub>3</sub> Concentration Measurement**

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### **ABSTRACT**

Ammonia (NH<sub>3</sub>) is an important substance in the nitrogen cycle. Agricultural emission NH<sub>3</sub> has become one of the most important problems causing the worldwide air pollution. To understand and control of NH<sub>3</sub> emission production depends on sampling and measurement techniques that includes devices, instruments and procedures. Suitable sensors with excellent properties are the first and very important part in detection of NH<sub>3</sub>. Solid state sensors are used very often for detecting and measuring of NH<sub>3</sub> concentration. The basic principle of these sensors presents a change of their conductivity depending mainly on the interaction of measured gas and sensitive material (the layer on the sensing element) of the sensor (such as SnO<sub>2</sub> or ZnO mainly). The electric resistance of n-type semiconductor under the high oxygen partial pressure is high. Since electron transfer from the semiconductor into adsorbed oxygen leads to an electron-depleted space charge region near the semiconductor surface. Almost any type of reducing gas is detected by this mechanism. Properties of the semiconductor sensor type are determined by this mechanism. A serious problem of

solid state sensors is their strong dependence on temperature and humidity mainly.

Laboratory experiments with these sensors that are based on SnO<sub>2</sub> were carried out for a long period. The experiments were focused on:

- detail study of air humidity influence on measuring low concentration NH<sub>3</sub> in air under influence its temperature.
- the experiments with the sensors that increased their sensitivity to detect of NH<sub>3</sub> concentration by their various connecting in sensor matrix in one case. The good results depend mainly on the same characteristics of used sensors. The influence of soft X-ray radiation on changes of sensitivity (and stimulation conductivity of the sensor sensitive material) was shortly studied as well. The obtained results are not fully consistent (the number of experiments was not quite sufficient).

SDEWES.2009.519

## **PCR Detection of Enteric Viruses in Treated Wastewater in Venice Area**

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### **ABSTRACT**

Enteric viruses are released in water by sewage and can cause numerous infections with different levels of pathogenicity to humans using treated wastewater or bathing in areas where treated wastewater is discharged. In this study, 20 treated wastewater samples, collected downstream of 10 distinct sewage treatment plants in the Venice lagoon area, were tested for enteric viruses (adenoviruses, enteroviruses, hepatitis A virus (HAV), reoviruses and noroviruses) by nested-PCR and integrated cell culture (ICC) nested-PCR, in order to find out the most suitable technique to rapidly screen enteric virus occurrence, to assess the most functional disinfection process and to establish which enteric virus could be used as an indicator of viral water contamination. Over a six-month period, adenoviruses were detected in seven sites (70%), enteroviruses were present only in one site (10%), HAV, reoviruses and noroviruses were always absent, and the most efficient disinfecting agent against viruses was sodium hypochlorite as against to peracetic acid and UV radiation treatment. Adenoviruses are proved to be more resistant to inactivation than other viruses and could be detected directly from the sample unmodified without propagation in cell culture. Furthermore, detection of adenoviruses by nested-PCR was proved to be more sensible, easier, faster and cheaper than other enteric viruses. Therefore, adenoviruses appear suitable to be used as an indicator of viral water contamination. The present study aims at defining suitable and rapid PCR techniques to detect some important enteric viruses in treated wastewaters, to prove which among the enteric viruses could work as a potential indicator of viral water pollution, to assess the disinfection efficiency of current water treatment processes, to evaluate the potential health risk for people using reclaimed wastewater and bathing in seawater where treated wastes are discharged.

SDEWES.2009.185

## **Monitoring and Fault Detection in MSW Incineration Process Using Multivariate Statistical Methods**

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### **ABSTRACT**

Process improvement is an essential activity in most industries. The demands are rising rapidly, with higher target of throughput, yield, and lower costs and less pollution are also desired. Therefore, better knowledge about the processes and their operations is needed to allow for better control. For thermal treatment of MSW by incineration, plant availability is a critical characteristic. Due to the continually changing in waste composition the incineration needs more advanced control concepts to effectively respond to unexpected process disturbances, to guarantee compliance with emissions standards and early determinate possible deviations. It is a complex and multivariate process. Although the main critical process parameters may be known, their interrelations are usually not known or they are non-linear. This makes monitoring and control more complex. Theoretical and experimental research has been carried out aiming at modelling these phenomena.

Application of multivariate statistic methods, PCA and PLS, is presented herein aiming at contributing to the improvement of the aforementioned specific problem of the incineration. They provide alternative approaches to fault detection and diagnosis extracting information from historical data. Two supporting modules for monitoring and control have been developed. Firstly the process operational region is defined based on historical data from continuous measurements. Then, in the validation module, the established plant operation region is used to assess values for the directly manipulated process-variables to guarantee to be within the acceptable operation conditions. The diagnostic module detects and analyses abnormal situations through the problem identification and suggesting possible actions based on engineering studies and expertise of the plant operators.

The present methodology is demonstrated on application to real process data. The results are interesting confirming the potential of the proposed approach.

## Conservation and Demand-Side Management II

SDEWES.2009.270

### Demand Side Management At Regional Level

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#### ABSTRACT

Demand side management (DSM) commonly is used to manage energy consumption for optimization of available or planned energy generation resources. Since regional level is found as the most appropriate energy planning level for promotion of renewable energy sources and for reduction of environmental impacts, the aim of research was to develop a system for implementation of DSM at regional level and elaborate the screening methodology for selection of most appropriate options for improvements. Regional DSM system is used to maximize the exploitation of renewable energy sources, to reduce CO<sub>2</sub> emissions and to find the optimal economical solution for renewable energy technologies in particular region. Two user groups - users of energy resources and energy end users are located in the centre of regional DMS system. Both those user groups are affected by different impacts like availability of renewable energy sources, availability and cost of technologies, presence of human factors, energy efficiency measures, etc.

Regional DSM system was developed and tested based on energy structure of Limbaži region. Limbaži region is a typical middle-sized rural region in Latvia. Its administrative structure consists of territories of five towns and 11 parishes. Region does not have connection to natural gas grid and for this reason it is possible to highlight the need for extended use of locally available fuel and renewable energy sources.

The next step of research was to develop a screening methodology for elaboration of proposals concerning successful implementation of regional DSM system. The screening methodology is based on theoretical and practical basics on decision-making, using a step-by-step approach: listing the possible options for improvements in different parts of regional DSM systems, selection and listing of criteria (performance indicators and reasons) for the analysis of improvement options, determination of weights and scoring system and calculation of total score for each option. Finally each option for improvements was ranked according to awarded points.

SDEWES.2009.427

## **Energy Efficiency Management in The Cities**

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### **ABSTRACT**

Cities all around the world are facing rapid increase of urban population where crucial issues like transportation, water management, air pollution and energy efficiency management are slowly but surely transfer from national government surveillance to the local municipalities' responsibility. Recent electricity and gas market liberalization in European countries demonstrates all the challenges that open market economy is bringing to energy consumers but also to the city governments. Energy dependency or independency, become crucial issue for future sustainable development of each urban area in the world.

Environmental issues are increasing as constant market needs for oil and gas. Energy and environment legislation and trading system for green house gas (GHG) emissions to atmosphere, moving toward renewable energy sources and energy efficiency. Awareness of climate change brought together Mayors from many cities around the Europe to sign Covenant of Mayors in February 2009, as a future action plan that will match EU three times 20 percent strategy till the year 2020, on a local level. That significant act, demonstrates how local government can take initiative for global good and use their power to change something.

Energy efficiency management in the cities help local government to focus on important energy projects that have business aspect and financial feasibility. Energy efficiency projects financing is another crucial issue, if return on investment in energy sector is not so attractive. Financial institutions or potential private investors concentrate than on price subventions or grants, which reduce lower rates loss and longer period of project implementation. ESCO models or some other innovative financial tools could make those projects possible to achieve. Field and desk research presented in this paper show how Croatian city of Rijeka took an energy efficiency opportunity to solve public lighting issue by using several techniques of strategic management in practice. Also, some other projects of energy efficiency in Rijeka will be presented in this paper, as an example of sustainability of energy efficiency in urban area.

SDEWES.2009.508

## **Energy Efficiency Trends and Policy in Slovenia**

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### **ABSTRACT**

The energy dependency of Slovenia is high (52.1%), but it is lower than the average energy dependency in EU 27 (53.8%). Slovenia imports all petroleum products, natural gas, partly coal and electricity. The energy intensity of Slovenia is higher for about 50% than the average in EU 27. The target of EU Directive on energy end-use efficiency and energy services adopted in 2006 is to achieve 9% improvement of energy efficiency within the period 2008-2016. The new target of the EU climate and energy package "20-20-20 plan" is 20% increase in energy efficiency by 2020. The Slovenian government since 1991 supported energy efficiency activities. The improvement of energy efficiency was one of the targets of energy strategic documents (Resolution on the Strategy of Use and Supply of Energy in Slovenia from 1996 and Resolution on National Energy Programme from 2004) adopted by the Slovenian National Assembly (Parliament) in the previous years. The Energy Act adopted in 1999 defines the objective of energy policy giving priority to energy efficiency and utilization of renewable energy resources. The goals of the "National Energy Action Plan 2008-2016 (NEEAP)" adopted by the Slovenian government in 2008 include a set of energy efficiency improvement instruments in residential, industry, transport and tertiary sectors. The target of the NEEAP is to save final energy in the 2008-2016 period, it amounts to at least 4261 GWh or 9% of baseline consumption. The indicators of energy efficiency trends show considerable improvement in the period from 1998 to 2007. The improvement of energy efficiency was reached in all sectors: manufacturing, transport and households. The paper analyses the structure, trends of energy consumption and energy efficiency indicators by sectors of economic activity. The review of energy efficiency policy and measures is described in the paper.

## Sustainability in Buildings I

SDEWES.2009.120

### **Accelerating Sustainable Buildings in Local Government: an Australian Study**

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#### ABSTRACT

Local Government is a significant component of the Australian landscape. In terms of the breadth of services it provides and as a market segment in its own right, local government can provide leadership for their communities and influence the market. They provide opportunities for driving change in the built environment sector (Yudelson, 2008).

The built environment is an intrinsic part of human life, significant for its social, economic and environmental impacts. Whilst providing shelter and other benefits, the built environment constitutes approximately one third of greenhouse gas emissions (OECD 2002, 2003). Around 30% of projected built environment emissions for 2020 can be mitigated cost-effectively, if changes were made at the present time (UNEP, 2007). Furthermore, as reported by McKinsey & Company (Bressand et al 2007, p. 13) large opportunities for improving energy efficiency exist across the different sectors. The potential demand reduction in 2020 through enhanced energy productivity can create 10% opportunities in commercial sector, and 30% in industrial sectors. It is noteworthy that most council assets would fall within these sectors.

In Australia, Local Government is the sphere of government that most often implements national and state regulations and outcomes. Local Government also manages substantial built assets, both newly commissioned and under maintenance on behalf of their communities.

The aim of this research is to identify ways that practitioners in local government can improve sustainable outcomes for their own Council's built environment. The focus is on areas within the control of practitioners. This research examines the current state of play in relation to the accelerating the uptake of sustainability in existing Council assets in Australia. This is done through understanding and documenting barriers and opportunities for accelerating sustainability in Local Governments' built assets and by investigating the factors of success of those Local Governments who are delivering improved sustainability outcomes. Through participatory action research, this research aims to extend that

understanding through trialling a practitioner improvement program and interventions in asset management with four participating Councils in the State of Victoria in Australia.



SDEWES.2009.290

## **Energetic Analysis and Diagnosis on Historical Buildings: the "ex-curia Maxima" Building in Torino City**

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### **ABSTRACT**

The activity of energetic analysis and diagnosis of building has been deeply developed during last years, due to many reasons; these main reasons could be resumed as:

- New European/National laws and Standard Codes on energy consumption of buildings;
- New environmental consciousness of people above all about energy consumption, energy saving and rational use of energy;
- Increasing of crude oil price and of all energy related prices.

Under these premises was born the co-operation between Comune di Torino – Facility Management Department, and EURO ESCO S.r.l., an Italian ESCo company, to perform energetic analysis and diagnosis of a sample historical building belonging to Comune di Torino: the “ex-Curia Maxima” building.

In this paper we'll analyze the building, the technical methodology of approach energetic analysis and all results of energetic analysis and final energetic diagnosis of the building

SDEWES.2009.089

## **Using of Recycled Polymers for Solution of Critical Details in Low-energy and Passive Houses**

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### **ABSTRACT**

The increasing quantity of waste materials is associated with continuously increasing need for their recycling and reuse. An important subgroup of waste materials are polymers. Selected polymers with suitable thermal and mechanical properties can be used with advantage also in civil engineering. The example of polymers meeting the above requirements is the waste polypropylene PP and waste polyethylene PE in low-density LDPE or high-density HDPE form. The above polymers represent more than 50% ratio of the total global production of polymers. This high production is associated with high production of wastes, which can be used as a source of material usable for other application. Application of recycled polymers suitably supports decreasing of energy exigency and thus the area of sustainable development.

One of current trends of energy savings in civil engineering is the proposal and construction of low-energy and passive houses. This new concept is associated with the arisen need to solve originated details both in terms of the design and material. On the basis of analyses details of critical areas were outlined. These include mainly the details of circumferential casing, which negatively affect the entire thermal-technical function of the passive and low-energy function. The details that can constitute problematic places in designing and construction are especially the following: corner details, wall beams details, opening fillup embedding detail, wall footing detail and others.

A new product made from recycled polymers, a window sub-frame and insulation block, was developed for low-energy houses elimination of a critical construction details. The window sub-frame provides the possibility to embedding fillup opening in the place of the thermal insulation of the external cladding. The insulation block provides the possibility to interrupt the thermal bridge between the foundation and the external or internal wall. Mentioned products meet thermal as well as mechanical requirements and also the requirements for the functionality and stability for its whole life cycle.

SDEWES.2009.327

## **Tradition and Innovation in Zero Energy Balance and Zero CO<sub>2</sub> Emission Housing Development**

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### **ABSTRACT**

The paper presents a research study and a final design proposal for new social housing in the peri-urban context of Tricase, a town located in Puglia, in the southern part of Italy. During the 19<sup>th</sup> century and especially up to the 1960's and 1970's residential buildings were predominantly designed and constructed to urgently respond to social and market's housing demand; thus low costs, by means of pre-cast, as well as low-tech or poorly simplified construction technologies, became the major focus within the urban formation of new residential areas; consequently urban planning and design generated 'fragmented' plans often neglecting the interactions with streets and plots in the structure of inner and surrounding urban textures. Furthermore the major part of residential building blocks resulted in thermally inefficient lightweight structures which overheated during summer season and suffered high rates of heat loss in winter.

The present work was primarily designed to investigate the influence of outdoor spaces and new building conception as an integrated system: 'sustainable' paths linking the open spaces within the area -and the same area to the remaining part of the city- have been regarded as key elements and components to improve overall microclimatic conditions in the fringe- peri-urban Tricase sector. The design approach combines passive tools -high thermal inertia brick walls' structure as an evolution of the stone traditional construction of the region, high albedo materials, solar shading devices, ventilation strategies, etc.- with solar and wind energy micro-generation, to finally provide a comprehensive plan for 'Zero local CO<sub>2</sub> emission and Zero Energy balance' housing development. Further investigations have been analysed to accurately assess the study of the thermal performance of the buildings, using different software tools and a CFD simulation with Ansys CFX for natural ventilation strategies. Results show that integration of active and passive techniques in urban and building types can lead to feasible, energy efficient and low-cost solutions where the respect of place history and tradition may translate into high quality performing buildings within recognizable urban environments. In the search for a reasonable co-habitation between innovation and tradition it is therefore evident that technological innovation can find elements of generation in the critical reading of context and in the consciousness of existing environmental resources.

SDEWES.2009.567

## **Strategies and Indicators for Sustainable Planning - Building Performance Evaluation**

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### **ABSTRACT**

The current building practice is not only marked by the climate change, but maybe even more evidently through massive economic changes - economic crisis. The necessity for development of new strategies for sustainable planning and building in terms of economic, ecologic and social sustainability is more urgent than ever.

A problem that "green" building is still faced with is the short term thinking of the investors - energy efficiency and environmentally friendly technologies and materials require higher construction costs, with return-of-investment periods longer than 15 years. Most of the investor-architecture however is handled as merchandise for resale - a portfolio investment - where return of investment is calculated for very short periods; or the operational costs are carried over to tenant.

The focus of the prevalent building performance assessments often lies exclusively upon analysis of heating energy consumption, the primary energy consumption for construction and demolition as well as the cooling-, lightning- and operation energy demand is hardly considered. This approach hinders the evaluation of the life-cycle benefits of increased construction costs and efforts for sustainable planning.

This paper researches the coherences of different parameters determining the sustainability performance of a building and proposes an implementation plan within integrated planning process. A life-cycle oriented strategy for building performance evaluation, which quantifies the sustainability potential of a building, will be presented. The evaluation is carried out by the means of sustainability indicators, which represent the In- and Outputs occurring thorough the lifecycle of a building such as: Resources, Energy, Capital, Information. The indicators reflect the ambivalent nature of a building as composition of tangible and intangible characteristics, and are structured in sustainability triangle:

- Economy: construction cost, investment, life cycle cost (operation, cleaning, maintenance, demolition), yields, fungibility
- Ecology: resources- and energy consumption, emissions
- Socio-Cultural Aspects: aesthetic and cultural values, human health and wellbeing

The implementation of the strategy enables development of different scenarios already in the early planning phases, as well as the identification of potentials and deficits, enabling the achievement of ecologic, economic and social optimum.

SDEWES.2009.422

## **Efficiency Investigation and Energy Saving for Ground Source Heat Pump in Office Building**

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### **ABSTRACT**

In office buildings air conditioning has become current practice in North Western Europe. High internal loads, solar gains and increased comfort expectations are the main reasons. Cooling in office buildings can be achieved with classic cooling machines, natural ventilation, etc. In this paper an innovative energy system is described and based on a ground source heat pump with vertical borehole heat exchangers (BHEs). The system is the largest borehole field in Flanders. GSHP systems exchange heat with the ground, often through BHEs and delivers heating and cooling to a 16.000 m<sup>2</sup> office building. The performance is determined by the HP characteristics itself, and by the thermal process (extraction and injection of heat) in the ground with its BHEs.

Despite the fact that GSHP technology is known since almost 50 years, market penetration of GSHPs in large Belgian public buildings is still in its infancy. Once the energy demands have been calculated the number of BHEs, the distance between them, ... can be simulated. By extending the heat pump system from a heat extraction system to a heat storage system, a BTES system is created which has very interesting advantages (natural cooling, regeneration, high efficiency, low operational costs, etc.).

This paper presents the simulation results of GSHP and BHEs. The optimum number of vertical borehole heat exchangers is simulated. Typically, information on energy transfer and consumption, flow rates and temperatures is obtained. This information is compared with a predefined 'reference' installation, existing of contemporary energy systems. This allows to define the actual primary energy savings and environmental benefits.

## Biomass, Biogas and Biofuels: Potentials and Limitations III

SDEWES.2009.414

### Biomass for Energy in Poland

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#### ABSTRACT

The Polish resources of renewable energy, that is, energy amount potentially available from renewable sources, is currently estimated at 1160000 TJ per year. In this potential energy stream, the share of biomass - including energy crops, dry and wet agro-waste, and fuel wood - is more than a half. While the over-all potential of renewable energy is utilised to 17.5%, the actual level of utilisation of biomass resources is about 32%.

Of the different types of biomass, the highest level of utilisation exceeding 95% can be seen for dry agro-waste and fuel wood, with firing or co-firing for heat and power generation being the main conversion technologies. The utilisation of wet agro-waste and energy crops is only beginning as the current level is about 2%, with energy crops being mainly processed to transportation fuels.

In the national strategy of energy supply until 2030, a considerably increased share of renewable energy in the supply of final energy - 20% as opposed to less than 7% at present - is foreseen. This can be achieved mainly by improving the utilisation of biomass resources, adding also improved utilisation of wind energy. The Polish government has proposed an action program aimed at increasing biogas production from wet agro-waste, but its potential effect in terms of energy generation can only be of secondary importance. It is necessary to focus on energy crops as the potential for expansion of their production is very large.

Estimates of land area available for the production of energy crops are widely differentiated, ranging from 1 to 2 million ha. It is generally agreed that the system encompassing land use for energy crops and the associated conversion of biomass energy to heat and power has to satisfy three basic requirements: sustainable biomass production, economic feasibility and high energy efficiency. Any future action program aimed at the expansion of energy crops will have to include the component of monitoring the environmental impact and influence on food production.

SDEWES.2009.466

## **Geographic Distribution of Economic Potential of Agricultural and Forest Biomass Residual for Energy Use in Croatia**

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### **ABSTRACT**

Biomass as a renewable energy source is a vital component of meeting the EU targets for renewable energy in Croatia. This paper provides information about energy potential of different type of biomass in Croatian counties and cost of biomass at the power plant location considering transport distance of biomass, transport cost and size of power plant. Energy potential for biomass in Croatian counties was calculated for wheat straw, corn stover and for forest residual, since those are considered economically viable at the moment. Different methodologies are used for calculating energy potential of biomass. Methodology used for estimating removable residual from wheat straw is based on minimum requirements for soil protection, animal feeding and bedding. For estimating removable potential of corn is used assumption of 20% for calculating fraction on the field that go uncollected and 50% for calculating amount of corn stover for soil protection. Methodology used for calculating potential of forest residual is based on assumption that 12% of the total mass of tree is forest residual which can be removed from forest and used in energy purpose. Potential of wood waste from wood industries in this study is not calculated because these residuals wood industries are using it for own consumption and for production of pellets and briquettes. Results of this study indicate that the energy potential of wheat straw is 7.9 PJ; corn stover 4.4 PJ and for forest residual energy potential is 5.9 PJ.

SDEWES.2009.356

## **The Possibility of Biomass Production in Energy Plantations of The Short Rotation in Recultivated Areas of Waste Sites of Open-pit Coal Mines**

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### **ABSTRACT**

The industrial, general-economic, as well as civilization developments of the human community are inconceivable without the energy sources. The non-renewable fossil energy sources such as coal, oil and natural gas, which account for 2/3 of the known world reserves of the primary energy sources, are still the most important. The coal accounts for 46% of the reserves.

Serbia is rich in lignite which is mainly used for the production of electricity. The increasing need for electricity, and the limited hydro-energy potential, as the most important, eco-friendly, renewable potential, force to the orientation to the further increase of the lignite production in open-pit mines. It implies the disruption of orography, destruction of the ecosystems and further endangering of the environment. Only within two main coal basins the current ecosystems will be destroyed on over 1000 km<sup>2</sup>. In order to alleviate the harmful effects of the open-pit mines, it is necessary that the mining activities be accompanied by the biological recultivation. As the forest ecosystems are the greatest absorbers of CO<sub>2</sub> and other pollutants, and the most efficient filters of the solid substances, the forest recultivation should be favoured. The part of the recultivated areas can be used for establishment of the energy plantations of the fast-growing dendroflora or perennial herbaceous plants. In order to define the models of these plantations, The Ministry of Science and Technological Development supported the researches aimed at the determination of the post-exploitation areas suitable for the short rotation plantations in the Kolubara basin. Besides the research of ecological conditions of the post-exploitation areas, research of the development and productivity of biomass in the forest cultures established during the biological recultivation, the comparative experiment was set with the number of fast-growing species, in order to determine the technology of the soil preparation, feeding, density of sowing, measures of protection, effects of phytoremediation, the selection of the mechanical devices, the analysis of the economic parameters, etc. The aim of the research is the increase of the participation of energy from biomass and partial replacement of the fossil fuels, in accord with the Kyoto Protocol, Davos Forum and other international agreements. This paper presents some results which are the part of the project.



SDEWES.2009.480

## **Forest Fuel Availability, Harvesting Costs and Economy of Wood Fired CHP in Europe in The Light of Case Studies in Poland, Czech Republic, France and Western Russia (2005-2009)**

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### **ABSTRACT**

The aim of the case studies was to evaluate the wood biomass availability for fuel, to find cost-effective wood fuel production technology and to calculate the wood fuel supply costs in each study location. Also the most suitable combustion technology was evaluated and heat and power production costs and the associate emissions of heat and power production in CHP power plant were estimated.

Four case studies were implemented between 2005 and 2009. These studies, under the projects 'EU's wood fuel resources, energy technology market and international bioenergy trade mechanism' and 'Global Forest Energy Resources, Sustainable Biomass Supply and Markets for Bioenergy Technology' aimed to enhance the business possibilities of mitigating the climate change. The solution for this was to enhance renewable energy production by introducing best available technologies and promoting the Finnish bioenergy know-how in growing global markets and studying the availability, technology and economy in different European locations.

The studied locations were selected by local experts and associated companies and all sites were suitable for energy production with wood-fired CHP - i.e. demand for heat and power existed and wood fuel was available with a reasonable cost-at-plant. In Poland (2005) the studied site was an existing power plant in Bialystok (100 MW boiler to be retrofitted for biomass). In Czech (2007) a location in the town of Zabreh was studied (new 50 MW CHP). In France (2008) a location in Chaumont area was studied (new 50 MW CHP). In Russia (2009), the city of Kostamuksha was studied as a location for a plant (new 150 MW CHP).

Following conclusions were made in the course of the studies:

Availability of wood fuel was sufficient at all locations (branches and tops from final fellings, small wood from thinnings and forest tending type cuttings, additional fuel from root wood. Availability of forest industry side products is generally rather poor)

Costs of wood fuel at plant were reasonable (slightly lower costs in the Eastern Europe)

Chipping At Roadside -method is the general supply chain solution for forest fuel procurement at all locations

The economy of heat and power production with forest fuels is a challenging issue at all locations (Subsidy schemes for renewable forest fuels available in all studied locations)

The project was funded by the Finnish Funding Agency for Technology and Innovation, TEKES. In addition to TEKES, six Finnish companies (John Deere, Metso Power, Neste Oil, Pentin Paja Ltd, Stora Enso and Vapo Ltd) participated in the funding and the executive group of the project. VTT was responsible of the case studies. Finnish forest research centre METLA provided GIS data for the calculations and was responsible of the availability calculations.

SDEWES.2009.517

## **Evaluation of Phaeodactylum Tricornutum as Potential Biomass for Biofuels in The Venice Lagoon Area**

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### **ABSTRACT**

This work focuses on the characterization of potential available microalgae *Phaeodactylum tricornutum* as biomass in the Venice Lagoon area for the eventual develop of a big scale biofuels production plant. Microalgae are efficient carbon dioxide fixers and they appear more photosynthetically efficient than terrestrial plants. The potential production of biodiesel from algae oil is much more feasible than biodiesel from seeds oil. Microalgae can play an important role on bioremediation too. In this meaning the Venice Lagoon is a suitable environment, the Lagoon offers the opportunity of developing algae cultures, is rich in microalgae and it can be consider a natural growth field of algal biomasses. The polluted water from river mouth discharging into the lagoon could be used for aquaculture purpose and the bioremediator action of the algae can be utilized to improve the water quality, eliminating the contaminants and the nutrients excess. The study provide a mathematical model for the optimal growth of *Phaeodactylum tricornutum* analyzing the photosynthetic, respiration and irradiation parameters.

## Renewable Energy Planning and Implementation II

SDEWES.2009.125

### **Efficiency and Effectiveness of Promotion Systems for Electricity Generation from Renewable Energy Sources - Lessons from EU Countries**

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#### **ABSTRACT**

##### **1. Introduction**

Currently, a wide range of strategies is implemented in different countries to increase the share of electricity from renewable energy sources: One of the most controversially discussions is whether trading-based (e.g. the recently announced Guarantee-of-Origin (GoO) trade) or technology-specific instruments (like feed-in tariffs (FIT)) lead to preferable solutions for society. An important issue in this context is that both systems are actually market-based and both systems are introduced by policy makers and, hence, create an artificial market. Finally, in both systems the final electricity customers (or the tax payers) will have to cover the support costs.

##### **2. Method of approach**

The core objective of this paper is to discuss the perspectives of quota-based GoO trade for an efficient and effective increase of RES-E in comparison to FIT. The analysis is based on a formal framework how instruments works using the computer model GREEN-X. Major focus is put on the analysis of the additional extra costs for the electricity consumers/tax payers. Finally the problems that might arise from trading systems e.g. of 'windfall profits' (e.g. if existing capacities or already cost-effective technologies are included in a trading system) are investigated.

##### **3. Results**

The major results of this analysis are: (i) The success stories of growth in RES-E in EU member states in recent years has been triggered by FIT implemented in a technology-specific manner at modest costs for European citizens. The main reason is the long term price security of the system combined with technology diversification of support. Compared to short term trading in renewable certificate markets the intrinsic stability of feed-in systems appears to be a key element for success. Hence, currently a well-designed

(dynamic) FIT system provides a certain deployment of RES-E in the shortest time and at lowest costs for society.

At present, quota-based trading systems show a low effectiveness although comparably high profit margins are possible. Firstly, a major problem are the producer profits possible especially for the cheapest options in the market. This leads to correspondingly high additional costs for customers. Secondly, market mechanisms seem to fail in TGC-systems, but, why should competition work in a TGC market if it does not function in the conventional European electricity market? The large incumbent utilities favour trading systems since this scheme gives them the chance to hedge risks and therefore prefer higher profitability.

#### 4. Conclusions

The most important conclusions of this analysis are: (i) regardless which strategy is chosen it is of superior relevance that there is a clear focus on the exclusive promotion of new capacity; (ii) A well-designed (dynamic) Feed-in tariff system provides a certain deployment of electricity generated from Renewable Energy Sources (RES-E) fastest and at lowest costs for society; (iii) Promotion strategies with low policy risk lead to lower profit requirements by investors and, hence, cause lower costs for society.

SDEWES.2009.133

## **Factors Guiding the Development of Photovoltaics in Croatia**

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### **ABSTRACT**

The PV industry is the fastest growing renewables industry in the world. However, that trend seems to bypass Croatia, the country with one of the highest average solar radiations in Europe. The reasons for the slow introduction of PVs in Croatia are multiple, and they vary from legislative barriers to financial incapability to support this rather expensive technology. In 2007 new legislature for renewables was set, including feed in tariffs for PVs. However, the support for PVs is at the moment limited to a total of 1MWp installed capacity. This limit seems rather low compared to some countries, such as Spain and Germany, where already installed capacity is few hundred megawatts. Nevertheless, taking into account Croatian limited financial resources 1MWp limit seems to be reasonable to some extent. The new Energy Strategy sets ambitious targets for utilisation of solar energy, and for realisation of those targets some changes in legislation will have to be made. With the new legislation, and likelihood that additional changes and simplification will be made as response to requirements of EU acquis and new Croatian Energy Strategy, it can be concluded that the PVs and other solar applications will have brighter future under Croatian sun.

SDEWES.2009.318

## **Development of Basic Criteria for Establishing of Feed-in Tariffs in R. Macedonia**

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### **ABSTRACT**

All existing research for calculation of the hydro potential in R. Macedonia shows that the small hydro power represents significant part of the overall hydro potential.

Lack of hydro energy production and Government energy policy has been a stimulated development of several independent energy production projects.

According to the hydrology base of Macedonia, the amount of 1088 GWh of electric energy can be produced by small HPPs, which would represent 17.5 percent of the technically usable hydro potential of the country.

The hydro potential of the Republic of Macedonia, including the small watersheds, that can be used for construction of small HPPs is analyzed and presented in several studies. One of the basic conclusions is that the small watersheds are mainly not used at all. Their usage would improve the balance of the renewable at the expense of non-renewable energy resources. R. Macedonia is oriented to importing electricity, because the domestic energy potential can't meet the total energy consumption. So, each new energy source is precious and very welcome, both for the energy production, as well as the country budgeting. Having in a mind all of the above, there is an obvious need of energy production improvement, which can be realized through the following solutions:

- Exploitation of domestic rather than import energy resources
- Exploitation of renewable rather than non-renewable energy resources

Our earlier investigation reviewed international practices with feed-in tariffs and set out options for such a feed-in arrangement. The objective of this work is to present the estimates of the investment and operational costs of selected small hydro power plants (SHPPs), across a range of sizes, as a base for establishing the level of the feed-in tariffs.

Following this, the objectives are:

- Set out the recommended approach for developing a feed-in tariff;
- Provide a draft set of feed-in tariff Rules on Methodology that is suitable for implementation in Macedonia; and
- Present data that indicate the likely level of feed-in tariff that would need to be offered to attract interest.

The results of the preparatory work for establishing of feed-in tariffs will be presented.

SDEWES.2009.136

## **Sustainability Estimation of Energy System Options Which Use Gas and Renewable Resources for Domestic Hot Water Production**

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### **ABSTRACT**

The reserves of quality energy-generating products such as oil and gas are symbolic (less than of 1%) and various types of coals are low-quality lignites so strategy of energy development until 2015 in Serbia including more uses of renewable energy sources. One of the possibilities for fossil fuel substitution is the biomass and solar energy using for heat production. This paper presents evaluation of various energy system options for the purposes of hot water production in heating plant. The heating-plant is situated in one of the biggest municipality of the city of Belgrade and represents the integral part of Public Utility Company. It produces and delivers heat energy for heating and domestic hot water to customers (approximately of 17000 households). The gas fired boiler for thermal energy production is used with total boiler installed capacity of 10 MW. It is assigned a several possibilities that include using renewable energy instead of fossil fuel for thermal energy produces in domestic hot water production. So, in this paper sustainability evaluation of different energy options for few cases in regard to thermal energy obtained are shown: 1) thermal energy from the gas combustion; 2) thermal energy from the gas combustion and solar collection; 3) thermal energy from the biomass combustion; 4) thermal energy from the gas and biomass combustion; 5) thermal energy from the gas and biomass combustion and solar collection. In the calculation, the operation mode of 250 m<sup>3</sup>/h flux and temperature mode of 60/40°C is used. Also, the calculation is made for the Apricus type of collector, total collector surface of 5000 m<sup>2</sup> and total installed biomass fired boiler capacity of 3 MW. In order to compare of different energy system options the method of multicriteria analysis is done. This method integrates various multidimensional criteria according to present efficient method in estimations of complex system sustainability and the processes of making decisions. There is a little dependence of subjectively making decision i.e. results not depend of various analysts. Basic set of energy indicators with relation to different aspects of sustainable development is defined. All the weight coefficients of criteria are calculated by mathematical model using mutual relation of particular values for each option and criterion (indicator) when priority give to certain criterion. Obtained results are compared by General Index of Sustainability which is the measure of system complexity.



SDEWES.2009.201

## **Integrated Resources Planning in River Basins: a Case-study of The Cuiaba River Basin in Brazil**

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### **ABSTRACT**

Integrated Resources Planning (IRP) is the most advanced approach which has been applied for the expansion, or forward, planning of the electric power and gas industries. It was widely used in the late eighties and early nineties in the USA, Canada and Denmark. It has been applied in those countries mostly by vertically integrated utilities, motivated by regulatory requirements. Although such types of utilities are still found in many parts of the world, the current challenge everywhere is to employ the IRP concepts in the new institutional framework of the electric power and gas industries, where competition is sought for in the production/imports and trade stages of these industries. In the latter case, the forward planning exercises are indicative ones, usually carried out by government bodies. The exercises provide highly valuable guidelines both for government, for policy making purposes, and for the market agents - producers, importers/exporters, carriers, traders, investors, etc. - in their strategic planning.

The current Brazilian Water Resources Law requires that the recently created 'river basin committees' produce 'water resources plans' for the basins under their jurisdiction. The basic idea presented in this paper is to extend the water resource plan into an integrated resource plan concerned to find out the best trade off among three very important regional development inductors, if they are well employed: water resources, electricity and natural gas.

Some results of a case-study carried out at the State University of Campinas, concerning modelling approaches and setting data basis for the Cuiaba's river basin in Brazil are also reported in the paper.

SDEWES.2009.557

## **Policies and Measures for Renewable Energy Sources and Achievement of Targets by 2020 in Croatia**

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### **ABSTRACT**

This paper is considering set up a longer-term perspective and plan of actions for the development of renewable energy infrastructure in Croatia in accordance with the package of implementation measures for the EU's objectives on climate change and renewable energy for year 2020. The objectives set out in the EU climate change and energy policies can only be achieved by significantly increasing the share of renewable energy sources in energy consumption, including electricity, heating and cooling and transport. Overall binding target (three sectors are concerned in renewable energy: electricity, heating/cooling and transport) and indicative pathway for renewable energy sources to be achieved by 2020 in Croatia is been calculated in accordance with Proposal for a Directive including position of the European Parliament adopted at first reading on 17 December 2008 and methodology described in Impact assessment document which is accompanying the proposal. The paper explores development of support scheme for renewable energy sources promotion in Croatia including feed-in tariffs, guarantees of origin and greenhouse gas emissions taxation. It is addressed the necessity for creating enabling environment for promotion of renewable energy sources and gradually remove barriers for its stronger penetration on the energy market.

## Advances in Distribution Systems

SDEWES.2009.106

### **Similarities and Differences in Optimization of Water- and Gas- Distribution Pipeline Networks**

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#### ABSTRACT

Accent is on determination of appropriate friction factor of the pipes and on selection of the representative equation for water or natural gas flow which is valuable for existing conditions in the looped network of pipelines. Note that in a municipal gas pipeline, natural gas can be treated as incompressible fluid (liquid) i.e. as water or oil. Even under this circumstance, calculation of water pipelines cannot be literary copied and applied for calculation of gas pipelines. This means that inappropriate usage of friction factor, equally as e.g. inappropriate usage of water flow equations for calculation of gas networks can lead to inaccurate final results. Various equations have been proposed to determinate the head losses due to friction, including the Darcy-Weisbach, Fanning, Chezy, Manning, Hazen-Williams and Scobey formulas. These equations relate the friction losses to physical characteristics of the pipe and various flow parameters. Darcy friction factor (somewhere known as Moody factor) is the main parameter of the Darcy-Weisbach equation. The Fanning factor is not the same as the Darcy friction factor (which is 4 times greater than the Fanning Friction factor). The development of 'Moody Chart' which enables engineers to plot the Darcy friction factor and the use of the personnel computer to calculate the Darcy Friction factor has led to a large reduction in the use of the Fanning friction factors. The Fanning formula is very similar to the Darcy-Weisbach formula but the hydraulic radius of the pipe work must used, not the pipe diameter. These two factors are for water or gas flow. But the Darcy-Weisbach and the Fanning also formulas in their basic form are only for water (liquid) flow. If we apply these equations for gas flow without modification, discharges i.e. calculated flows will be in relative correct range of accuracy but deviation of calculated pressure drops (head losses) from real values cannot be neglected. Note that the Darcy-Weisbach formulas are not synonym with Darcy friction factor, equally as the Fanning formula is not synonym with Fanning friction factor. Factors are main factors in related formulas. Darcy friction factor is recommended after different authors for different flow regimes such as laminar, smooth, turbulent, etc.

Authors of these factors are e.g. Renourad, Blasius, Moody, Colebrook, Altshul, etc. Possible modification of the Darcy-Weisbach equation adjusted for gas lines will be shown in this paper. Also, should be noted that physical meaning of Darcy and Fanning friction factor are the same. First is in common use in Europe and in civil and petroleum engineering, while the second one is more common in America and in chemical engineering. Chezy, Manning, Hazen-Williams and Scobey formulas are only for water, i.e. for liquid flow and these factors cannot be used for gas pipeline calculation. Introduced in the early 1900s, the Hazen-Williams equation determines pipe friction head loss for water, requiring a single roughness coefficient. Unfortunately even for water it may produce errors as high as  $\pm 40\%$  when applied outside a limited and somewhat controversial range of Reynolds numbers, pipe diameters and C coefficients. Not only inaccurate the Hazen-Williams equation is conceptually incorrect. Some of these limitations will be discussed. Few novel techniques for determining of friction factor as neuro-fuzzy or similar will be commented. Finally, in this paper will be compared few iterative methods for determining the optimal hydraulic solution of water- and gas-pipeline networks which take form of ring-like, such as, Hardy Cross, modified Hardy Cross, node-loop method, etc. Speed of convergence will be compared and discussed. This will be done for one simple network with three loops. Diameters of pipes in this pipeline will be optimised like in water- or gas- distribution network.

SDEWES.2009.446

## **Security of Supply Concerning Integrated Electricity and Gas Distribution Network Planning**

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### **ABSTRACT**

The paper is focused on a security of supply issue within the concept of integrated electricity and gas distribution network planning concerning January 2009 gas supply crisis.

The bases of the integrated electricity and gas distribution network planning will be elaborated as an example of energy system analyses and planning complying to the concept of the sustainable development. The overall aim is rationalisation of both the energy consumption and investments in the energy systems. The focus of the paper is on the later issue, within which the planning criteria and methodology will be given. However, the additional restrictions imposed by the concept of integral planning bring also additional uncertainties as well as the corresponding risks. The one presented in this paper addresses the issue of security of gas supply and the connected issue of security of electricity supply.

The example of the electricity network in a region with established gas consumption is given as a bases for the assessment of the impact of the potential interruption of the gas supply similar to the January 2009 on the electricity distribution system and electricity supply. Both electricity and gas load curves will be evaluated resulting with the assessment of the increase of the electricity peak load in the case of the partial or total gas supply reduction.

The conclusion of the article should be an assessment of the need, as well as possible suggestions, to impose additional criteria for the electricity distribution network planning for areas with certain levels of gas consumption or ensure other means for addressing the increased risk for the reliability of electricity supply.

SDEWES.2009.624

## **Optimization of Waste Heat Utilization in Pipeline Compressor Station**

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### **ABSTRACT**

Gas turbine driven pipeline compressor stations employed in existing pipelines and also in those that shall be built due to increasing demand for natural gas present significant potential for production of additional electricity and useful heat by utilizing the waste heat from gas turbine process. For utilizing the waste heat existing systems are usually upgraded with a heat recovery steam generator, steam turbine and balance of plant equipment, which are used to produce electricity via conventional combined gas and steam cycle process.

Paper analyzes and compares several various configurations both in the terms of thermodynamic and economic criteria. In order to find an optimal configuration of a new system an exergo-economic HRSG optimization is conducted for finding the compromise between the exergy losses and investment costs of HRSG surfaces. Preferred single pressure, dual pressure and triple pressure system configurations are examined in typical operating scenarios of pipeline compressor station. For each scenario cost of electricity, cash flow and internal rate of return are calculated. Sensitivity analysis has been performed in order to estimate system viability in case of varying fuel prices and CO<sub>2</sub> emission certificates for each scenario. The results of the performed investigation are based on realistic compressor station data and could be used as a guideline for further research and development in this field.

SDEWES.2009.134

## **Energy Generation Potential Within the Conventional Natural Gas Transmission and Distribution System**

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### **ABSTRACT**

The paper deals with a possibility of energy production within a natural gas transportation system. The conventional system has a hierarchical structure, based on 3 or 4 pressure stages, interconnected via Pressure Reduction Stations (PRS). The highest pressure stage is referred to as the transmission sector while lower stages constitute the distribution sector. In the high pressure stage, energy is supplied to compressor stations compensating for friction losses in pipelines. Following the gas flow to subsequent lower pressure stages, its pressure is reduced in pressure regulators installed at the PRS's.

The main drawback of the conventional system is its thermodynamic irreversibility, i.e. the loss of potential work that could be generated while reducing the gas pressure. Within the first part of work, a thermodynamic model has been created to analyze changes in physical energy and mechanical exergy within the conventional gas transportation system.

The second part of work deals with the application of turboexpanders (expansion turbines) at the PRS's allowing one to extract a part of the potential work and to produce electricity while reducing the gas pressure. The performance of turboexpanders has been analyzed for various thermodynamic parameters, i.e. the inlet and outlet gas pressure, the gas preheating rate and the expander isentropic efficiency. A second-law based definition of the expander's efficiency has been proposed.

Furthermore, relevant technical, economic and environmental aspects have been analyzed. Problems concerning flow regulation, overpressure protection and frequency control have been identified and described. A brief economic model has been created to analyze the feasibility of the expander installation in terms of the key economic parameters. Finally, environmental benefits resulting from generation of additional electric power in the gas transmission system as well as the legal situation concerning the qualification of the produced energy have been discussed.

## Sustainability in Buildings II

SDEWES.2009.455

### **Multiparametric Programming Approach for The Home Energy Management Problem**

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#### ABSTRACT

A home energy system basically consists of appliances linked via a communication network allowing interactions for control purposes. Load management allows users to adjust their power consumption according to expected comfort, energy price variation and CO<sub>2</sub> equivalent rejection. For instance, during the peak periods, according to weather forecasts and inhabitant requests, it could be possible to decide to delay some services or to reduce some heater set points in order to reduce CO<sub>2</sub> equivalent rejection or to run requested services even so.

Load management is all the more interesting that there are local storage and production means such as battery, photovoltaic panels or wind mills that provide additional flexibilities. Combining all these elements leads to systems with many degrees of freedom that are very complex to manage by users.

In this paper, energy management problem is formulated as a scheduling problem in which energy is considered as a resource shared by appliances and consuming energy activities are considered as tasks. Three different aspects can be taken into account as objective function: user's comfort, economical criteria, ecological criteria. In this paper, the user's comfort is the only addressed. An adaptation of the static Resource Constraint Project Scheduling Problems (RCPSP) has been developed to improve the management of electric heating systems. This approach is able to co-ordinate the electric heaters while satisfying a maximum power resource constraint. Nevertheless, the solved problem requires precise predictive models, for example, for weather forecast. This communication is based on a new three-layer (anticipative layer, reactive layer and device layer) household energy management system able to satisfy the maximum available electrical power constraint as well as maximize the user's comfort criteria. It focuses on the anticipative layer in which uncertainties modeled as interval are introduced. Uncertainties related to weather forecast and amount of energy consumptions are addressed. An algorithm based on the Branch & Bound procedure and the multiparametric linear programming are implemented. Two examples are proposed to illustrate the applicability of this algorithm in energy management problem.



SDEWES.2009.685

## **Acoustic and Thermal Behavior of Concrete Building Blocks with Cork**

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### **ABSTRACT**

In order to improve the acoustic and thermal behavior of concrete blocks, cork has been added in its composition. Different admixtures with distinct cork proportions and particle size distribution were studied. Parameters such as the weight of the block and its compressive strength, water absorption and bulk density were taken into account. Acoustic behavior was assessed by performing airborne sound insulation tests in masonry walls using the manufactured concrete blocks containing cork. The experimental tests were carried out in the two adjacent horizontal acoustic chambers of the 'Instituto de Investigação e Desenvolvimento Tecnológico em Ciências da Construção - ITeCons', according to the ISO 140-3 standard. The thermal performance of the block was characterized by the experimental evaluation of the thermal conductivity of the material.

SDEWES.2009.423

## **Influencing Households Energy Behaviour, a In-situ Measuring Campaign**

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### **ABSTRACT**

The behaviour of household members has a significant impact on the resulting energy consumption of a household. Studies show that within the same buildings with the same installations, energy consumption can be reduced by an average of 37% by a more economical behaviour. There exists therefore, a large potential to reduce the demand by influencing behaviour. The question remains how this potential can be addressed. VITO conducted, in collaboration with the Catholic University of Louvain-la-Neuve, the SEREC-project. This project investigated the socio-economic factors influencing residential energy consumption; furthermore, in the larger framework different tools have been developed. Several were tested and evaluated in a number of dwellings in this research. They address both energy consumption for heating as well as electricity consumption. The tools are completely different, but all were designed to help make householders aware of their energy-related behaviour and to provide recommendations on energy saving measures. For each case, potential changes in habits were followed-up. The observed range is quite large, as full scale audits of every dwelling were performed as general comparisons of annual consumption were made. To gain more insight into the effectiveness of the tools, several families participated in in-depth sociological interviews. The overall results show the strengths and weaknesses of the different tools. More generally, the results reveal some of the key properties of recommendations that are necessary to ensure effectiveness for behavioural change.

SDEWES.2009.075

## **Energy Performances and Architectural Integration of Solar Plants in Buildings**

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### **ABSTRACT**

The energy performances of active solar systems, solar thermal or photovoltaic, are strongly influenced by the orientation and slope used in the installation of solar panels. Actually there is the tendency to favour the solar plants which present a strong integration with the building from an architectural point of view. Nevertheless this design approach can involve heavy penalization in the annual performances of the installed solar plants. It is therefore necessary to provide the designers a clear and complete information, since the first phase of the project, about the influence on the performances connected with installation parameters different from those normally suggested.

In this paper the problem of this penalization is analysed in detail by means of simulation models and an estimation on the basis of the consequent calculation procedures is presented. The results show that orientation and slope deeply influence not only the amount of solar radiation available on the surface of the solar collector but also the mechanisms of energy absorption. The analysis is extended to different types of collectors like flat plate collectors, evacuated tubular collectors with or without compound parabolic concentrator. The aim is to permit a precise consciousness of the problem in order to achieve the best compromise between architectural exigencies and energetic efficiency.

SDEWES.2009.450

## **The Importance of Controlling Underground Heat Storage**

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### **ABSTRACT**

In most buildings more than 40% of the energy consumption is used for heating and cooling. Providing technology to lower these costs is definitely one of the most efficient ways to reduce carbon dioxide emissions.

Underground heat storage is a promising technique to store heat energy over a season. The problem addressed in this paper concerns controlling such systems. This is important for two related reasons: how can be avoided that all heat stored in summer is consumed midway winter? If this happens, the system would become unreliable and will probably not be implemented much. In order to avoid this, the underground storage field is often chosen too big, so that the operation mode is guaranteed, but this raises the investments costs. One elegant solution to circumvent this conflict is by the utilization of robust optimal control algorithms.

Because the heat and cold demand of a buildings is not a priori known, the most convenient way to control such a system is by implementing a stochastic dynamic programming algorithm, which takes into account the stochastic nature of heat and cold demand, the dynamics of the storage field and the physical constraints on the temperature and devices. One important feature of such a control algorithm is that it can deal with model errors: even if the model prediction is (partly) wrong, the control law can guarantee stability of the system and this at the lowest costs.

The controller is tested on a simulation, where a complex model is used to mimic all features of a real underground heat storage field. The conclusions from this simulation are: (i) the size of the current field is approximately twice to big. Thus so are the investment costs. (ii) the controller remains stable under all tested operational conditions, like severe winters, hot summers, etc...(iii) under some conditions, like a mild winter, it is most profitable to drain excess heat from the field at the end of the winter. Such control decisions will never be taken by classical control strategies.

## Biomass, Biogas and Biofuels: Conversion Processes II

SDEWES.2009.247

### **Biodiesel Production from Vegetable Oils: a Comparative Study**

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#### **ABSTRACT**

High viscosity and low volatility of vegetable oils compared to diesel lead to injector fouling and carbon deposits in engine cylinder while using them directly in engines. Biodiesel from these vegetable oils produced by transesterification process could reduce viscosity considerably and improve the volatility. The properties of methyl esters produced from rubber seed oil, coconut oil and palm kernel oil, which are locally available especially in Kerala (India) are presented here. The viscosity of methyl esters of these oils is found to be comparable with diesel fuel as per ASTM D6751-02. Biodiesel from rubber seed oil (with high FFA) was produced by employing two-step pretreatment process (acid esterification) to reduce acid value from 48 to 1.72 mgKOH/g with 0.40 and 0.35 v/v methanol-oil ratio and 1.0% v/v H<sub>2</sub>SO<sub>4</sub> as catalyst at a temperature of 63(±2)°C with one hour reaction time followed by transesterification using methanol-oil ratio of 0.30v/v, 0.5w/v KOH as alkaline catalyst at 55(±2)°C with 40 minutes reaction time to yield 98-99% biodiesel. Coconut oil and palm oil, being edible oils and having similarity in fatty acid composition, transesterification (with 0.25v/v methanol-oil ratio, 0.50%w/v KOH as at 58(±2)°C, 20 minutes reaction time for coconut oil and 0.25%v/v methanol-oil ratio, 0.50%w/v KOH as alkaline catalyst at 60(±2)°C for palm kernel oil will convert them to 98-99% biodiesel. Experiments showed that rubber seed methyl ester is found as a good alternative to diesel considering all the characteristics including economy, even though viscosity of coconut methyl ester was found to be closer to that of diesel fuel.

SDEWES.2009.050

## **Sugars and Lignosulphonates Fractionation from Spent Sulphite Liquor by Membrane Processes**

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### **ABSTRACT**

Spent sulphite liquor (SSL) produced in pulp and paper mills is a biomass resource which is usually concentrated and burnt in steam boilers. Yet, the biorefinery concept may add value to the by-products contained in SSL.

The overall goal of this work was preliminary studies of the application of membrane separation processes to the liquor generated by acidic magnesium-based sulphite pulping of eucalyptus. The particular objectives were the separation of the lignosulphonates (LS) from the sugars for subsequent fermentation, and the lignosulphonates fractionation to produce valuable products.

Laboratory experiments were conducted in total recirculation, natural pH and 25°C, using Ultrafiltration, Nanofiltration, and Reverse Osmosis membranes from Alfa Laval, Dow Filmtec, and Microdyn-Nadir.

Microdyn-Nadir UP010 membrane showed the widest gap between the rejections of the lignosulphonates (68%) and total sugars (3%), being promising for fractionating the lignosulphonates and separating the high molecular weight LS from the sugars contained in SSL. The separation of the low-medium molecular weight LS from the sugars contained in UP010 permeate might be accomplished by Ion Exchange.

Concentration experiments at a membrane pilot plant and an economic assessment are essential to enlighten about the technical-economical feasibility of the membrane processes.

SDEWES.2009.513

## **Preparation of Chars with High Adsorption Capacity from Peach Stones by Pyrolysis**

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### **ABSTRACT**

This study involves the pyrolysis of peach stones using a fixed-bed reactor operating under atmospheric pressure to investigate the influence of pyrolysis temperature on the product yields, and to investigate the quality of solid product-char. Under static and steam atmospheres, final temperature range of 300-700°C was carried out with the samples having an average particle size when the heating was 10°C/min. Final temperature of 500°C gave the highest bio-oil yield of ~26% under steam atmosphere. For the solid product the yield of 27% was attained at the same temperature. Chars and liquid products obtained under different temperatures were characterized by elemental analysis and FTIR. For the characterization of chars produced, SEM images were taken and their surface areas were determined from N<sub>2</sub> adsorption data at 77 K using BET equation.

For the second part of this study, nickel adsorption capacity of the chars from aqueous solutions was investigated and the effects of different parameters such as; amount of char, initial concentration and contact time were determined. It was found that under optimum conditions, adsorption of Ni<sup>2+</sup> from aqueous solutions with an efficiency of higher than 90% efficiency is possible.

Analysis has shown that it is possible to obtain valuable liquid products similar to petroleum and activated carbons from the renewable source, peach stones.

SDEWES.2009.344

## **Energy Analysis of Distillation Units in The Process of Yeast and Alcohol Production**

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### **ABSTRACT**

This paper reports a simulation analysis of energy consumption in steam distillation units, which are used as a part of manufacture in the factory for yeast and alcohol production. Distillation units are stored in the final stage of alcohol manufacture route following the anaerobic fermentation processes. The main products of distillation process are: 96% Vol. ethyl alcohol and technical alcohol, which presents the mixture of ethanol, aldehydes and some other less volatile components than ethanol.

The simulation analysis has been made by simulation software Aspen HYSYS. The validity of the model in terms of mass flow rate, temperature and pressure was examined using actual plant data at steady-state conditions. Comparison between model results and plant data shows good consistency and enabled the retrofit design with improved efficiency of the unit.



SDEWES.2009.059

## **Development of The Boiler for Combustion of Agricultural Biomass by Products**

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### **ABSTRACT**

Republic of Serbia consumes about 15 million tons of equivalent oil per year (Mtoe). At the same time potential of the renewable energy sources is about 3.5 Mtoe/year. Main renewable source is biomass, with its potential of about 2.6 Mtoe/year. There from 60% of biomass source is agricultural biomass. Mainly, that type of biomass is collected, transported and stored in form of bales. At the same time in one of the largest agricultural companies in Serbia (PKB) there are over 2000 ha of soya plantations, and there are 4000 t/year of baled soya straw available, none of which being used for energy purposes. Therefore, efforts have been made in the Laboratory for Thermal Engineering and Energy of the "Vinča" Institute to develop a technology for utilizing bales of various sizes and shapes for energy production. Satisfactory test results of the 1 MW experimental facility - low CO levels and stable thermal output - led to the building-up of a 1.5 MW soya straw bales-fired hot water boiler, with cigarette type of combustion, for the purposes of greenhouse and office heating in the PKB. Further more, achieving good results in exploitation of that hot water boiler, the next step is building up the first combined heat and power (electricity) production facility (CHP), which will use agricultural biomass as a fuel, in Serbia.

## Electricity Transmission and Management

SDEWES.2009.538

### **Environmental Performance and Sustainability Reporting in The Electricity Sector**

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#### **ABSTRACT**

The environmental performance of companies has been measured through the level of disclosure of environmental reporting (Adams & Larrinaga, 2008). Both academics and corporate throughout (Moneva and Llena, 2000; KPMG, 2008) have observed that there is a significant relationship between the sectors with the greatest polluting potential and a high level of disclosure, showing a legitimacy approach of these companies (e.g. chemicals, electricity, oil and gas,...)

The aim of this paper is to observe the intra-industry differences to the environmental performance, considering the institutional conceptual approach. Thus, we develop a content analysis from a methodological comparative and longitudinal perspective related to environmental reporting disclosure by the main electricity Spanish companies. More recent environmental and sustainability reports (2005-2007) of these companies have been analysed, checking the level of compliance with the Global Reporting Initiative (GRI) indicators and other standards related to emissions, environmental expenses and investments, impacts on biodiversity, relations with the stakeholders, environmental management awards and verification level of the reporting achieved.

Results show a positive evolution of the environmental reporting of these companies, but without significant differences between the amount and the quality of the information disclosed among them. An isomorphic process can be also checked by the level of compliance with GRI guidelines during these years in this sector. Thus, we can conclude that the electricity sector environmental performance is based on the institutional context.

SDEWES.2009.069

## **The Present and Future Relationship Between Dso and The Customer Regarding Service Quality**

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### **ABSTRACT**

As a result of electric power market liberalization, the energy market in Croatia began to open in 2006. and continued to gradually open until July 1, 2008., which means that as from that date competitive energy market was full opening of retail markets and all customers have the legal right to choose their electricity supplier. HEP Distribution System Operator is sole distribution system operator in the Republic of Croatia, and organizationally consists of 21 local distributors covering the whole territory of Croatia.

Electrical power market liberalization typically aims to improve the position of customers. The possibility of supplier choice and consequent competitive pressure results in a better match of service supply and user demand. It is generally recognized that service quality is an important aspect. Not only low price are important, but high service quality also matters to customers. Price and quality are complementary; together, they define the value that customers derive from consuming electricity.

The trend now is considered the use of advanced meters as part of an Advanced Metering Infrastructure (AMI). Advanced metering refers to the full measurement and collecting system, which included customer meters, communication networks and data management systems. The meters (smart meters) in an AMI often can use collected data based on programmed logic. They offer additional functionality including a real time reads, power outage notification and power quality monitoring. That allow price setting agencies to introduce different prices for consumption based on the time of the day and the season.

This paper will present initial experiences in service quality implementation in HEP DSO. Also, a vision for a future distribution system in Croatia will be discussed, with areas that will be key for technology development and the advantages of the new electricity market.

SDEWES.2009.146

## **Financing Off-grid Rural Electrification: Country Case Nepal**

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### **ABSTRACT**

Rural electrification in Nepal has started more than four decades back. Still a large section of the rural people (61% of the total population) is living in the dark. Rural electrification is among the priority sectors of the government and a number of donors' programme. Micro hydro and solar PV are the most commonly adopted technologies in the off grid rural electrification of Nepal. However, there is a huge financial gap between the cost of the rural electrification and the affordability of the rural people. Bridging this gap is a crucial issue that needs to be addressed to improve electricity access in rural areas. The financial mix in the off grid rural electrification is generally characterized by subsidy, community equity or investment of private developer and or credit. This paper discusses the various financial approaches used as credit and subsidy in the rural electrification programmes.

The paper is based on a case study carried out in Nepal. The study included data collection regarding the financial mix in rural electrification investments and a questionnaire survey aimed at verifying the smartness of the subsidy policy, the existing rural electrification market (with micro hydro and solar PV), investment risks and credit investment options for off-grid rural electrification, as well as investment policy of financing institutions in this sector. The survey was carried out with various key stakeholders including micro hydro installation, supply companies, solar PV companies, and local non-governmental organization and financing institutions. We have reviewed the historical development of subsidy policy in the country and, in particular, the results of the energy subsidy policy introduced in 2000.

The analysis revealed that for micro hydro electrification schemes, subsidy covers about 55 to 60% of the total project cost while 40 to 45% of the project cost is borne by the rural villagers in the form of equity and/or loan. In case of solar PV, subsidy covers only 27% of the project cost where as 73% of the project cost need to be borne by the villagers.

Respondents emphasized on smartening the subsidy policy, decentralizing decision making process for making the subsidy delivery process smooth and also the need of credit guarantee mechanisms for minimizing the investment risk and attracting more private financing institutions on the sector. Based on the analysis made, conclusions are put forward for the sustainable development of the rural electrification sector.

SDEWES.2009.088

## **Application of Neural Network for Zagreb Load Forecasting**

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### **ABSTRACT**

Load forecasting is needful to the operation of electricity companies. This paper presents a study of short-term load forecasting using Artificial Neural Networks (ANNs) and applied it to city of Zagreb (Croatia). The goal of it is to enhance the energy-efficient, reliable operation of a power system and better planning of energy production.

Historical load and weather data obtained for the month January 2006 were used.

The main stages are the pre-processing of the data sets, network training, and forecasting. Inputs for ANN are hour of the day, day of the week, temperature, wind and rain forecast and the output is load forecast for a given hour.

## Sustainability in Buildings III

SDEWES.2009.687

### **Is E-learning a Tool to Improve Sustainable Hotels?**

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#### ABSTRACT

E-learning is based on information and communication technology (ICT) and supports the educational process. Due to important results achieved, e-learning is continuously gaining relevance in hotels, and in educational institutions.

Despite the undisputable importance of e-learning in education sector, it is very important in the tourism industry, mainly because it contributes to develop and consolidate the knowledge management.

This research, presented in this article, aims at analysing the contribution of e-learning in improving sustainable hotels. The research reveals that hotels consider that e-learning increases productivity and production volume, since their mean values are  $x_m=4.15$  and  $x_m=4.09$  respectively, in a Likert scale from 1-nothing to 5-strong. On the other hand, e-learning contributes very much for the employees motivation ( $x_m=3.71$ ). However, this influence is moderate in absenteeism ( $x_m=2.53$ ) and in turnover ( $x_m=2.94$ ). Globally, the hotels of the sample consider that e-learning enhances very much the competitiveness regarding the ten strategic factors under investigation ( $x_m=3.59$ ). This research allows concluding that managers' opinions about e-learning strategies are dependent on the hotels' category in 40% and on head-office nationality in 50%.

It is also possible to identify four organised groups, which have independent strategic profile and behaviour in evaluating the impact of e-learning in performance quality, employees' productivity and motivation. In fact, hotels' sustainability is a consequence of the involvement of employees in the hotel management. We conclude that the mean values of the four groups are superior to moderate, in terms of e-learning to improve sustainable hotels: Group 1:  $x_m=3.44$ , Group 2:  $x_m=3.49$ , Group 3:  $x_m=3.52$ , and Group 4:  $x_m=3.91$ , in a Likert scale from 1-nothing to 5-strong.

SDEWES.2009.697

## **Possible Energy Efficiency: a Case Study from South East European University**

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### **ABSTRACT**

In the last few years following the trend for commitment of climate changes, several university campuses started with planning about decreasing of emission of green house gases in order to perform CO<sub>2</sub> management and to raise the level of energy efficiency. As an effective approach towards this problem area, the implementation of methodology for long term planning has been identified in order to decrease the emission of green house gasses. This was also in correlation with the other plans of development of the campus especially with the main project and the strategy for development of the same.

The purpose of this paper is to present the draft plan through the application of the optimization measures to reach the level of high energy efficiency campus as well as to build capacities for production of energy from renewable resources in order to replace completely the consumption of electric power from own resources and to achieve the level of zero emission of green house gasses and ECO CAMPUS.

SDEWES.2009.686

## **Thermal Performance of a Slab On-ground Floor During the Heating Season: Case Study**

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### **ABSTRACT**

The evaluation of heat losses in a ground floor is relevant to estimate the thermal behavior and energy performance of buildings during the heating and cooling seasons. To assess the contribution of the overall energy performance of buildings, the International standard ISO 13370 proposes a simplified method to estimate heat losses through elements in thermal contact with the ground. In this standard different floor constructions are considered.

In the present work, in order to evaluate the thermal behaviour of a real slab-on-ground floor, gathering a set of different edge conditions, were performed ground temperature measurements in the vicinity of a peripheral wall during the heating season. The different edge conditions are related with outside ground surface level changes. Theoretical studies based on ISO13370 and steady-state numerical method applications were also performed for different real configurations.



SDEWES.2009.579

## **Evaluating Sustainable Building and Urban Development Strategies Through the Lens of Sustainability Science**

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### **ABSTRACT**

As more attention is paid on ameliorating the construction industry's negative impact on climate, we are beginning to see more sustainable building strategies being implemented in the various jurisdictions. Common strategy instruments include performance standards and rating systems, design guidelines, building regulations, product labeling scheme, preferential purchase policies, incentives for sustainability assessment and procurement, demonstration projects, material information portal and sustainable urban development concept.

This paper provides a brief review of these key strategy instruments before assessing them within the framework of sustainability science – a field that generates knowledge on the complex interactions between natural and social systems and their roles in affecting Earth's sustainability. Put in general terms, a sustainable building or urban development policy that can contribute toward a more sustainable industry in a “sustainability-scientific” way must address a wide range of sustainability issues in an integrated manner (that is, being integrative), enable stakeholders to reflect and adopt their roles in realizing a sustainable industry (that is, being reflective and participatory) and be relevant to the most pressing issues for that particular place in which the strategy is applied (that is, being place-based). This approach challenges the fundamental structure of many of the strategies reviewed; as a result, we are able to suggest general changes to conventional sustainable building strategies.

SDEWES.2009.458

## **Utilizing the Tourist Ecolabel-award Scheme for Singling Out Useful Criteria of a New Environmental Brand for Residential Buildings**

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### **ABSTRACT**

The Eco-label brand is assuming a role more and more important in the context of the environmental quality certification of products and services, especially in sight of the new ambitious aims of greenhouse emissions containment and of more efficiency in the utilizing of the sources of energy and the resources. Recently the hypothesis has been introduced concerning a European eco-label brand for the buildings, due to the consciousness that the building sector is of primary importance in the economic and social life of the countries. Such brand should mean an integral approach to the environmental problems concerning the construction, the exercise and the disposal of the materials used in the buildings, in the whole life cycle. Its main aim would be, as well as protecting the environment and using the resources with more appropriately, also ensuring better comfort conditions to the occupants.

## SIDE EVENTS

### STORIES project workshop

The main objective of the STORIES project <http://www.storiesproject.eu> is to facilitate RES penetration in islands, through modifications in the legislative and regulatory framework that will adopt energy storage technologies. Local workshops of STORIES project will be organised in parallel with SDEWES conference in order to increase awareness of the wider public and local/regional authorities on the benefits that will derive from the adoption of RES in combination to energy storage for the local community.

The latest findings and project results will be presented including:

- Market applications for energy storage systems in islands - case studies
- Set of existing regulations and legislative framework related to RES implementation
- Cost-benefit analysis of energy storage systems
- RES and hybrid systems barriers assessment and recommendations to overcome them
- Investigation of tariff schemes for energy storage technologies
- Scheme for the market organisation of autonomous electricity systems
- SWOT analysis and Roadmap for the introduction of hybrid RES/Storage systems

Participation in workshop will be free for all participants of SDEWES conference and representatives of all local/regional authorities, RES companies, media, policy makers, RES developers, etc.

Chairman of STORIES workshop will be Dr.sc. Manos Zoulas

STORIES project is co-financed by the Intelligent Energy - Europe (IEE) programme and it is an official partner of the Sustainable Energy Europe Campaign 2005-8.

### BIOSIRE project workshop

BIOSIRE project <http://www.biosire.eu/> aims to establish a shift towards bio-diesel and electric propulsion for fleets, ships and special vehicles in tourist areas in Spain, France, Greece, Italy, Croatia and Austria. Local actions are directed at market transformation and changing the behaviour of fleet operators, tourists and residents, farmers and potential suppliers of used cooking oils. These actions cover the full production and distribution chain: fuel supply, distribution network, fleet operators and final users. Recommendations for new areas will be formulated, in addition to a variety of transferability activities that will directly involve new tourist regions in project actions and stimulate their launching of

new programmes. Local workshop of BIOSIRE project will be organised in parallel with SDEWES conference in order to increase wider population awareness and awareness of local/regional authorities on the benefits of collecting used cooking oil, producing biodiesel from used cooking oil and using hybrid vehicles in tourist sector and National parks.

Project results will be presented at this side event including:

- Set of existing regulations and legislative framework related to biofuels
- Different models for collecting used cooking oil
- Experience from using Hybrid vehicles in partner countries and Croatia – case studies
- Used cooking oil potential in Croatia

Participation in workshop will be free for all participants of SDEWES conference and representatives of all local/regional authorities, RES companies, media, policy makers, RES developers, etc.

Chairman of this section will be Prof.dr.sc. Neven Duić.

BIOSIRE project is co-financed by the Intelligent Energy - Europe (IEE) programme.

## **Building a research career in the European Research Market: EU institutional and financial tools**

The main objective of this side event is to make the case of a good example of the implementation of the EU policy specified in the following institutional and financial tools: the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers, the EURAXESS Services Network and the specific programme People of the 7<sup>th</sup> FP.

The side event will be divided into two sessions:

The first session will focus on the good example of collaboration among the Greek EURAXESS Services' Network, the Greek People NCP Network and the People Network project. This collaboration is of outmost importance in so far as the EURAXESS Services' network plays a leading role both in spreading information on EU policies and instruments and in facilitating the adoption of relevant national policies.

The second session will focus on the institutional tool of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers (C&C). The aim of this session is to increase the awareness of the wider public on the rights, roles and responsibilities of researchers as well as of their employers and funders. The C&C is a

major component of the European Union's strategy to stimulate employment and economic growth, by setting up a competitive, transparent and open labour market for researchers.

The overall objective of the event is to show affinities and synergies between the Networks involved leading to good practices that would help the promotion and the implementation of the above EU institutional and financial tools to the benefit of the researchers.

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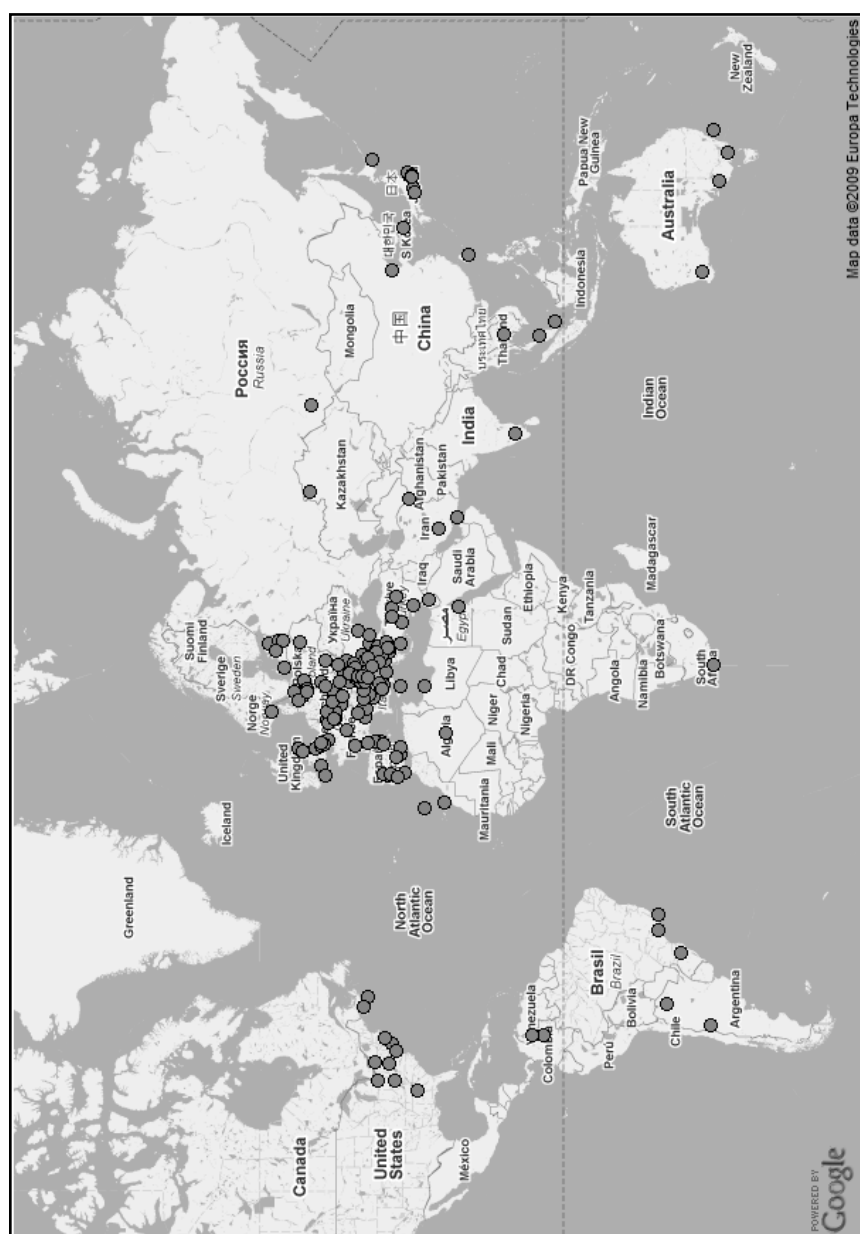
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