



The Growing Impact of Decentralised Actors in Power Generation: A Comparative Analysis of the Energy Transition in Germany and Japan

Oliver Wagner^{*1}, Maïke Venjakob², Judith Schröder³

¹Wuppertal Institute for Climate, Environment and Energy, Döppersberg 19, 42103 Wuppertal, Germany
e-mail: oliver.wagner@wupperinst.org

²Wuppertal Institute for Climate, Environment and Energy, Döppersberg 19, 42103 Wuppertal, Germany
e-mail: maïke.venjakob@wupperinst.org

³Wuppertal Institute for Climate, Environment and Energy, Döppersberg 19, 42103 Wuppertal, Germany
e-mail: judith.schroeder@wupperinst.org

Cite as: Wagner, O., Venjakob, M., Schröder, J., The Growing Impact of Decentralised Actors in Power Generation: A Comparative Analysis of the Energy Transition in Germany and Japan, *J. sustain. dev. energy water environ. syst.*, 9(4), 1080334, DOI: <https://doi.org/10.13044/j.sdewes.d8.0334>

ABSTRACT

This paper argues that, although Japan's and Germany's energy transition paths differ in detail, a trend towards decentralisation is clearly evident in both countries. Based on comprehensive screening, own stocktaking and the results of a stakeholder dialogue, this paper highlights the motivation for different local actors to enter the energy market in both countries. Although there are challenges to success in a market dominated by large energy companies, this paper argues that the benefits to local communities outweigh the efforts. Overall, it is shown that democratisation and the decentralisation of the energy system are suitable to facilitate a successful transformation process in both countries.

KEYWORDS

Energy transition, Decentralisation, Community energy, Power, Politics, Energy market, Participative governance.

INTRODUCTION

It can be inferred from the Paris Agreement that the reduction of greenhouse gas emissions required to limit climate change necessitates a transformation of the energy sector [1]. Renewables and their decentralised dissemination play an important role in this context. Much research has already been done on technical innovations to decentralise energy production [examples include (offshore) wind parks, improved solar cells, and mini combined heat and power plants]. However, the focus is not only on technological innovation. Emphasis is also placed on the energy transition being adopted and implemented by new actors that pursue innovative and different organisational forms to challenge the incumbents and the inflexible market structures [1]–[4]. In this context, Becker *et al.* [1] state that new actors are usually incorporated in the process following their involvement in renewable energy projects. Fuchs and Hinderer [2] present interesting examples of such incorporation at the local level in Germany. Geels *et al.* [3] show the importance of new actors based on a German-British comparison of socio-technical transition paths in the energy sector. For the established energy industry in Germany, Berlo *et al.* [4] show that new actors are gaining in importance, while the 'old energy industry' seeks to develop strategies to preserve its vested rights. Recent research has

* Corresponding author

increasingly looked at such change processes not only from the perspective of ‘social innovation and community energy’ in general [5], but also as an overview in Europe [6]. Since the beginning of the 21st century, investment in locally operated and managed wind, solar, biogas and geothermal plants has grown. Energy initiatives of the community, energy municipalities and energy cooperatives emphasise the empowerment of cities, communities and neighbourhoods in the face of the energy transition [7]. This implies that decentralisation may be a guiding principle for sustainable and comprehensive quality assurance in the energy supply system [4]. Energy initiatives based on local collaborative solutions that can be established by groups of individuals (for example, in cooperatives, community trusts and foundations, limited liability companies or non-profit customer-owned enterprises), local authorities or private-public mixed forms (local partnerships) are often referred to as ‘local energy communities’. Since these local initiatives can enable the development of sustainable energy technologies and benefit local communities and municipalities in various ways, it is expected that they will play an important role in the energy transition in general [4]. For example, both local energy communities [8] and newly founded municipal utilities [9] may become a key part of the transition to a sustainable energy economy. Irrespective of the legal form of such undertakings, which also depends on the national legal framework, decentralisation is often linked to another process: the promotion of direct democracy and the influence of the public on energy and climate policies, known as ‘participatory governance’, enhance the role played by decentralised actors in the context of the energy transition.

The opportunities for local autonomy in political processes vary greatly from country to country. Germany’s constitutionally guaranteed municipal self-administration is the basis for an active local energy policy [10], offering many opportunities to develop social [11] and institutional innovations for energy transition at the local level [12]. Despite the fact that municipal utilities (Stadtwerke) are widespread in Germany, they represent an institutional innovation when it comes to municipalities establishing new utilities. In countries with a much less pronounced tradition of the municipal ownership of energy companies, municipal utilities are, of course, even more innovative.

Experience from Germany shows that the remunicipalisation of ‘Stadtwerke’, i.e., returning energy supply control systems to existing municipal structures, is associated with a strengthening of the region. Berlo and Wagner [9, 13, 14] have undertaken several studies to this effect. Decision-makers trust that the regional economy will benefit from a municipal company and that the endogenous potential of local electricity and heat generation can be tapped for the benefit of the climate. Another important goal is on-site implementation of the energy transition. These are the findings for Germany. However, the subject of ‘Stadtwerke’ has since become an international phenomenon (as numerous examples from France [8], South America, the USA [15] and the UK show [16]).

Comparing Japan and Germany in this context sheds considerable light on the issue. After all, Japan and Germany each have a unique position in the global energy landscape, since they both made major changes to their energy and climate policies after the nuclear disaster at the Fukushima Daiichi nuclear power plant on 11 March 2011. This triple catastrophe off the coast of Japan, which caused an unprecedented multireactor meltdown at Fukushima, disrupted Japan’s energy supply and called into question the future of nuclear energy, the energy industry as a whole, and its structural characteristics. There was little public support for nuclear power before the incident, which then shattered belief in nuclear energy [17]. The disaster sparked a national debate on converting the energy system from a central system to a decentralised one [18], whereby the transferability of national experiences to other countries became an increasingly important issue [19]. Comparing Germany’s and Japan’s energy policies is interesting for several reasons. At first sight, the two countries are very similar with regard to the size of their economies (Japan ranks third and Germany fourth in the global economy), their surface area (Japan covers 377,970 km² and Germany 357,580 km²) and their specific economic and social order. However, they differ remarkably. For example, Japan has

virtually no fossil fuels of its own, and is isolated, being an island. In addition, Japan has a fragmented power grid with different frequencies and voltages. Against this background, the issues of independence, self-sufficiency and resilience in Japan are closely related to national security issues when it comes to energy policy decisions. Germany, on the other hand, has a uniform electricity grid and large coal reserves, and can exchange energy with its neighbouring countries. The strong social movement against nuclear energy also comes from the fact that job security is linked to domestic coal mining [20]. Against this backdrop, the German-Japanese Energy Transition Council (GJETC, www.gjetc.org) is a central source of mutual exchange. This body has developed extensive joint recommendations for the implementation and further development of energy transition, its numerous outreach events have helped enhance German-Japanese cooperation. The experience gained from the GJETC led to the presentation of the following key findings from the work, which can benefit the transformation of energy systems in other countries apart from Japan and Germany. A central incident in terms of energy policy was definitely the Fukushima disaster, which had consequences for the energy industry and energy policy in both countries.

The catastrophe had a considerable impact on national energy policy in both Japan and Germany because it caused the collapse of the ‘safety myth’ of nuclear power plants [20]. Since then, there has been a largely cross-party consensus in Germany that nuclear energy should be phased out. Eight of the 17 German nuclear reactors were shut down immediately after the accident, sparking a broad political debate about new regulations. At the end of this debate, the German parliament decided to phase out all nuclear power plants by 2022 [21].

The direct impact in Japan was even stronger. The country shut down all its nuclear power plants, either temporarily or permanently. This meant that the loss of capacity had to be offset by drastic reductions in electricity consumption, and by burning more gas, oil and coal in conventional thermal power plants [20]. The nuclear phase-out also led to a higher share of fossil electricity generation in both countries, meaning that they will fail to meet their national climate targets for 2020. Nevertheless, analysis shows that both countries could be on track to meet their 2030 targets. This is technically feasible if nuclear power is constrained or completely phased out and offset by the increased use of renewables [17]. Decarbonising electricity and improving energy efficiency are therefore key mechanisms for achieving climate targets in both Japan [22] and Germany [23].

However, the two countries also differ considerably in ways that have a major impact on their national energy policy. To understand Japan’s and Germany’s energy policies, it is important to consider their situations. Japan is an island with few fossil energy resources, while Germany is a country with large coal reserves and industrial cities that are located on the European mainland. There is therefore a central difference between the two countries. While nuclear power gained the status of being a ‘home-grown’ energy source without strong opposition in Japan, there was resistance to nuclear energy by the ‘coal lobby’ and the public in Germany for many years. Due to its lack of natural resources and its isolated national electricity grid, Japan always saw energy self-sufficiency as part of its national security. In addition, the Japanese power grid is fragmented across several islands, featuring different current frequencies and voltages. The existing grid is therefore very vulnerable and electricity exchange is comparatively expensive, while Germany has a single grid and is able to trade electricity with its neighbouring countries [20].

Against the background of these fundamental differences, the aspect of power supply based on the principle of resilience is obviously the main driving force behind the establishment of ‘Stadtwerke’ in Japan. In addition, aspects of an ageing society play an important role in the establishment of local municipal energy supply companies, such as ‘Stadtwerke’. Not only does an ageing society require special, tailor-made services, but also ‘Stadtwerke’ can act as potential local employers for young people, curbing urbanisation and rural migration. The power of local energy initiatives and local entrepreneurship can considerably help create intangible and economic values for rural areas and communities [7].

Distributed generation is becoming increasingly an important part of energy systems, leading to the transition to a decentralised energy system and presenting a major challenge for utility companies [24] in Germany and Japan. This is because electricity generation used to be based primarily on fossil and nuclear energy sources in large power plants. In the future, electricity generation will increasingly be based on a large number of fluctuating renewable sources with comparatively low specific capacity. While large coal-fired power plants and nuclear power plants have over 1,000 MW of installed capacity, a small Photovoltaic (PV) system has only a few kW, and large onshore wind power plants have about 3 MW. In such a world with a vast number of small power generation plants, the challenge is to bring supply and demand of electricity into line under completely new conditions. After all, this is the prerequisite for a reliable electricity supply.

A recently published analysis of the municipalities involved in the three German renewable energy projects (Energy Municipalities, Bioenergy Villages and 100% Renewable Energy Regions) shows that many municipalities seek to achieve energy autonomy [25]. In Japan, renewable energy systems are often (co-)financed by citizen funds set up by municipalities, as in the case of Aizu Electric Power, private individuals and companies from the region join forces to invest in solar parks, as in Miyama City, or citizen-funded solar plants are installed on the roofs of public buildings, as in Iida City [26, 27].

Our hypothesis is that democratisation and the decentralisation of the energy system is suitable to facilitate a successful transformation process in both countries.

METHODS

Although various institutions such as the German Institute of Urban Affairs (Difu) and the Association of Municipal Enterprises (VKU) have attempted to gain an overview of the development of local utility companies through market observation, newly founded municipal utilities are not systematically recorded [28]. As part of a scoping study conducted by the Wuppertal Institute in 2012, a comprehensive inventory was produced on this topic. Based on various sources and the authors' own research, an overview of newly founded municipal utilities was compiled. Companies fell into the 'Stadtwerke' category if they were at least active in the electricity business [13].

Our findings for Germany with regard to newly established municipal utility companies were primarily determined by comprehensively screening all newly established municipal utility companies in Germany. Data records of the VKU [29] and a 'Diplom' thesis [30] served as key information. The data sets used include an overview of new municipal utilities set up by the VKU as well as a compilation of basic suppliers and distribution grid operators. The inventory was also supplemented by the authors' own research. The sources used included municipality and municipal utility websites, published city and municipal council resolutions, articles in the local press and specialist articles on various internet portals. The inventory includes all new municipal companies active in the energy industry that were founded between 2005 and 2016. However, the list does not include previously existing companies that had been renamed. Our analysis provides information about regional concentration, the size of municipalities, the legal forms of the newly founded 'Stadtwerke', the shareholders (private and public) of the utilities, the year of foundation and the role of strategic partnerships.

As a result of this stocktaking, 152 newly founded municipal energy supply companies were compiled in total. These will be examined more closely below on the basis of the above-mentioned characteristics. Although the aim of the survey was to cover as many new 'Stadtwerke' as possible, the study does not claim to be exhaustive.

The method used to gain insights into the development of 'Stadtwerke' and community power in Japan consisted of analysing the results of a stakeholder dialogue with representatives of Japanese and German stakeholders that are active and/or interested in the issue of energy decentralisation. The stakeholder dialogue method is a suitable concept and is defined as an organised meeting of stakeholders with different knowledge, values and backgrounds who

meet especially for this occasion [31]. The stakeholder workshops conducted represent a special form of stakeholder dialogue. In contrast to normal stakeholder events, such workshop discussions are not only conceived as a forum for exchange and understanding, but also allow the various stakeholders to learn together by means of a special form (e.g., discussion of lectures with scientific results) [32]. They also promote negotiation processes and the development of new collaboration [31]. Stakeholder dialogues are an important component of a stakeholder analysis, which is a suitable tool for identifying, in advance of the workshops, which stakeholder groups from the social environment will support a project idea and who will develop resistance to the idea [32]. The aim of our project was to bring actors in a decentralised energy industry from Germany and Japan into a dialogue that would enable them to learn from each other's transformation processes by identifying similarities and differences, and by examining possibilities for transferring success stories.

This method of presenting and discussing concepts and approaches in the context of energy decentralisation in Germany and Japan is beneficial because there are many cultural, legal and system differences. It is a way to understand how energy companies from another country create value and trade with each other [33]. The interaction of participants from both countries during stakeholder dialogues can spark new ideas for concepts, energy services or target groups. Mutual learning can be initiated by participants presenting their own business models and good practice examples. The fact that decentralised energy companies from Japan and Germany are not direct competitors facilitates open communication and cooperation.

Diversity – in the sense of stakeholders with different backgrounds and cultures – is closely linked to the concept of mutual learning [31], which is an established concept in participation projects related to innovation processes and sustainability. In stakeholder dialogues, learning takes place through the interaction of the various stakeholders. The idea behind this kind of stakeholder dialogue is that the interaction of stakeholders with different approaches and perspectives can lead to the emergence of new insights and innovation.

The aim of the GJETC project funded by the German Federal Environmental Foundation (DBU) and the Stiftung Mercator foundation is to show that national energy systems can be transformed more successfully, despite considerably different starting positions in Germany and Japan, if the two countries learn from their strengths, but also try to make their weaknesses transparent in a bid to avoid them in the future. The project revolves around a high-level scientific cooperation initiative, flanked by several stakeholder dialogues on various energy-related topics.

One of the stakeholder dialogues, co-organised by the Japanese Ministry of Environment, took place in Berlin on 24 January 2017. The dialogue involved German and Japanese representatives of companies active in decentralised energy generation and supply. Some of Japan's frontrunners of decentralised energy cooperation, including Aizu Power, Miyama Smart Energy and Ohisama Shinpo Energy, attended the event. German representatives also included pioneers such as Elektrizitätswerke Schönau, regional associations of municipal utilities such as Stadtwerke Union Nordhessen, as well as large renewable energy companies such as Lichtblick.

Even before the dialogue, there was a strong interest in the 'other' country's ideas and concepts of decentralisation. It was noted that Japanese stakeholders were particularly interested in the development of 'Stadtwerke' and energy cooperatives in Germany, whereas German stakeholders sought information about Japanese services (digitalisation, ageing society). Japanese stakeholders of local communities, local ministries or companies are currently immensely interested in the concept of German 'Stadtwerke'. This phenomenon is also reflected in the large number of enquiries received by the Wuppertal Institute for site visits and decentralisation debates.

A questionnaire was sent to the German and Japanese energy companies invited to attend the stakeholder dialogue, a few weeks before it was scheduled to be held. The companies were asked to respond to the questionnaire in writing, and to return it before the day of the dialogue. This ensured that: stakeholders spent time addressing the topic and were prepared for the

dialogue (a) and that all key views and findings were set out in writing (b). The response was positive: 13 of the 15 companies contacted completed and returned the questionnaire. The questions were divided into two parts, the first dealing with more general issues, the second with company-specific ones.

Overview of the questions:

- Part A;
 - What do you think is the role of decentralised actors in the future energy supply system?
 - What difficulties/barriers for decentralised actors exist in the current market?
 - What supportive policies/measures currently exist? Do they function satisfactorily to overcome the barriers? What additional supportive measures are required?
 - What do you think are the differences in basic conditions between Germany and Japan concerning the dissemination of decentralised actors (energy supply system)?
- Part B;
 - How do you evaluate your business environment in the past and today?
 - What benefit (job creation, added value, emission) has your company provided to your region (business area) compared to what the existing centralised energy supply system could have done?
 - Have you faced resistance or criticism from various local stakeholders (e.g., civil society, business, administration, politicians)?
 - What future do you expect for your business?

Around 60 individuals from Japanese and German energy companies, energy cooperatives, banks, ministries and research ultimately participated in the stakeholder dialogue.

RESULTS OF THE STAKEHOLDER DIALOGUE

Although the process towards decentralisation within the energy system began earlier in Germany than in Japan, there are many common challenges and opportunities involved.

Opportunities of a decentralised energy system

All stakeholders regard decentralisation as an important precondition for the energy transition and for mitigating climate change: a decentralised energy supply system increases the possibilities of using local renewable energy sources (including local wood biomass and hydropower). At the local level, there are better technical options for integrating Variable Renewable Energy (VRE) and for achieving demand-side management. Local or regional power suppliers balance each cell in sub-grids. Shorter distances allow the effective use of thermal energy, energy efficiency and energy savings can be optimised. Decentralisation also reduces energy transport costs and avoids energy losses.

Local production for local consumption is very effective for regional economic cycles. Besides energy independence, other strong motives for the stakeholders involved are regional added values and business opportunities for local companies. Regional knowledge and networks are crucial, especially for small projects such as local district heating. Local communities benefit by paying less to external energy providers, they also benefit from the new jobs created by decentralised actor companies and from the development of an entrepreneurial mindset in the local community. Business opportunities arise when a company joins forces with other companies, establishing cooperative relationships within an area. Finally, a decentralised energy supply system is also financially beneficial to municipalities: it is expected that any surplus electricity can be sold to neighbouring cities (e.g., large cities) via the transmission grid. Local companies can also have greater success in promoting environmentally friendly measures.

In Japan in particular, the issue of regional economic recovery is regarded as very important and is one of the key priorities for Japan's Prime Minister Shinzo Abe. However, energy security

and resilience or disaster prevention through local renewable energy supply is often highlighted. After the great Eastern Earthquake of 2011, a number of places became known for their progressive approaches, as their techniques proved effective and no power failures occurred. Several small decentralised plants, as opposed to a single large central system, are better able to compensate for disturbances occurring across all systems. This addresses resilience-enhancing characteristics of decentralised electricity generation, as discussed in the scientific debate. Examples include the use of combined heat and power plants to compensate for volatile generation from wind and PV plants, as well as the relevance of the factors of space and governance in decentralised electricity generation (see also the Discussion section).

German stakeholders also emphasise the financial mobilisation and activation of the public. One stakeholder is quoted as saying: “If people are enthusiastic about renewable energy, they will also be interested in energy saving (efficiency), e.g., e-mobility and sufficiency”. Stakeholders see opportunities for regional financial investments and the development of regional merchandising concepts. After the decision to phase out nuclear power stations in Germany, there was a sharp increase in the number of patents relating to renewables. The heated, decades-long debate over nuclear energy turned out to be an obstacle to investment and innovation. The diversity of actors in the field of renewables now offers end consumers a variety of products, services, innovations and price ranges.

One stakeholder mentions another reason for decentralisation: democracy and citizen participation. It is crucial to achieve independence from big energy suppliers. The installed renewable energy capacity in Germany is currently about 80 GW. Only 5% of this capacity is owned by the ‘Big Four’, over 50% is owned by private citizens and farmers (mainly local projects). Citizens’ trust in public institutions can be strengthened when local public companies operate the energy supply system. This includes cooperative structures that integrate citizens, making them co-owners and allowing them to benefit directly from their investment.

Supportive framework conditions

The deregulation and liberalisation of the electricity market, and the Renewable Energy Sources Act (EEG), introducing the Feed-in Tariff (FIT) for renewables, created supportive legal framework conditions for decentralisation processes in both countries. The FIT scheme was a good way to start mobilising financial resources for renewables. Japan’s FIT scheme was launched in 2012, Germany’s in 2004. Since then, both countries have introduced several modifications. Like Japan, Germany also switched from a fixed FIT scheme to a reverse auction system in 2017. One major difference is that Germany guarantees priority grid access for renewables, requiring grid operators to upgrade the grid if necessary. While in Germany, PV and wind generate similar average prices, Japanese’s FIT scheme mainly promoted PV for a long time, but wind is now catching up. What both countries have in common is that the FIT level declines over time for all renewable energy sources.

The highly volatile oil prices experienced in recent years were an important driver for the implementation of local district heating networks. Strong price fluctuations and discussions about the increased taxation of fossil fuels are important arguments in this context, because they reveal the difficulty in predicting the profitability of investment in such plants. Economies of scale for renewables and batteries also contributed to the trend towards decentralisation. In Germany, wind and solar energy are now cheaper than nuclear and fossil energy. Prices are expected to continue falling because many old and expensive PV systems will be excluded from the FIT system by 2023.

In Japan’s case, the guidelines established by the Ministry of Economy, Trade and Industry (METI) can be considered as supporting factors. Electricity retail companies are requested to disclose the carbon dioxide (CO₂) emission intensities of all electricity generated under the electricity retail guidelines. The law on sophisticated methods of energy supply structures requires that all electricity retailers selling more than 500 MWh of electricity per year need to make every effort to ensure that the share of electricity they supply from non-fossil fuel-based

power sources is 44% or more by 2030. Even though non-fossil fuel-based electricity includes nuclear power, the law provides a certain incentive to install renewable energy, as it has become difficult to recommission existing nuclear power plants following the accident at the Fukushima Daiichi nuclear power plants. This creates opportunities to increase the share of electricity from renewable sources so as to meet the target of 44%.

In Germany, basic regulations such as the EEG largely activated the population and supported the development of a decentralised energy system, as mentioned above. Stakeholders also mentioned promotional programmes, e.g., initiated by the German Federal Office for Economic Affairs and Export Control (BAFA) and the German promotional bank (KfW Group). The Act on Combined Heat and Power (KWKG) and the Renewable Energies Heat Act (EWärmeG) of the Federal State of Baden-Württemberg also provided for a minimum of renewables for new and existing buildings. The German Cooperatives Act (GenG) (with the existence of a cooperative auditing association and special features in the legal form, such as limited warranty) and a specific amendment to that act in 2006 paved the way for the establishment of cooperatives in the energy sector.

Stakeholders also described the population's interest and high acceptance of renewables, which was also promoted by regional added values. A growing number of households and companies seek to use energy and gas more efficiently, and also want to generate and store their own energy.

It was positively noted that emissions trading creates greater transparency due to the information provided on energy plants. Integration into the European grid market is seen as another positive factor.

Challenges for decentralised actors

Decentralisation also encounters difficulties. Japanese stakeholders still consider it a challenge to ensure a sufficient and stable energy supply based on renewables, especially in metropolitan regions. It is not easy to balance electricity demand with supply, due to the very limited volume of electricity transactions, particularly when demand is expected to grow beyond the supply capacity. In addition, the current grid infrastructure, low transmission capacity and persistent monopolies of incumbents hamper the development of a decentralised energy system. The ten major power companies in Japan still operate the grid infrastructure, and the capacity of transregional transmission lines in Japan is limited or partly incomplete. Energy supply, the distribution network and transmission grids will only be separated in 2020.

Furthermore, the FIT scheme in Japan appears to affect various stakeholders differently. While it benefits electricity producers, conditions for regional utilities have tightened. Disadvantageous modifications allow utilities to refuse PV projects being connected to the grid, for example. Since the introduction of the FIT scheme, electricity has been sold to grid operators, previously, self-produced electricity could be sold independently, keeping sales prices low. Japan's stakeholders are struggling with the economic environment: initial investment is expensive. For example, the Levelised Costs of Electricity (LCOE) for PV systems in Japan are the highest among the major industrialised countries, mainly because of the high construction costs. However, plant construction and operation costs are also falling in Japan, meaning that competitive prices can be expected by 2030 at the latest, making it easier for decentralised actors to invest in PV systems.

Last but not least, Japanese stakeholders fear that communities and citizens will be unable to fully grasp the value of using renewables. This means that they will not feel compelled to compete with fossil and nuclear energy over time, causing their interest in a decentralised system to diminish. Few Japanese citizens currently dare take the step of establishing an energy company. One important obstacle is the difficulty in recruiting qualified employees. There seems to be a need for cooperation between municipalities and increased communication, but this would require effort from all sides. Some participants emphasise the opportunities that

renewables offer rural areas, but fear there may be insufficient consumers in the region in the future to support decentralised actors, due to the ageing society.

The Japanese climate places further demands on the energy supply system: PV engineers are called on to develop efficient safety measures for implementing PV modules that take the Japanese climate into account. Winters are shorter in Japan than in Germany. Biomass combined heat and power plants are therefore economically unattractive, due to the lower demand for heating. In addition, wind conditions are less favourable in Japan than in Germany. Moreover, Japan has several different climate zones, ranging from a cold-temperate climate zone in Hokkaido with cold and snowy winters to the subtropics in Okinawa Prefecture. As a result, Japan needs to develop and use a highly adaptable renewable energy technology that takes into account the requirements of these different climatic conditions.

In recent years, the legal framework has become more difficult for decentralised actors in Germany as well. Frequent legislative revisions and complicated regulations create uncertainty and hamper business activities. Following the amendments to the EEG in 2014 and 2017, it is no longer possible to directly sell renewable electricity remunerated under the EEG. This renewable electricity must be sold to the EEX Spot, and loses its quality of being 'green'. Tendering procedures and a predetermined rate of renewable energy power by the government were introduced. As a result, especially small companies in the decentralised energy sector or voluntarily managed energy cooperatives are struggling to meet all the requirements. Until then, tendering processes were only necessary for large open-space PV plants. The system now also covers onshore and offshore wind energy, biomass and large rooftop PV systems.

This leaves little room for an active energy movement among citizens, even though they were the main drivers of decentralisation until then. Being aware of this, the Federal Ministry for Economic Affairs and Energy simplified the EEG for civic energy cooperatives. As a result, cooperatives may participate in tendering procedures, even if their project has not yet obtained permission for emission control. If they are awarded a contract, rather than receiving the price they offered in the tender, they are paid the value of the highest bid awarded. However, these exceptions are still not sufficient to ensure a diverse range of participants. Financial regulations such as the German Investment Code (KAGB) also make business difficult.

Further disadvantages generally arise with large-scale projects (e.g., offshore wind parks) or additional investment for grid expansion. Price competition between renewable and conventional energies remains unfair because the external costs incurred by nuclear and fossil energies are not reflected in their prices. Exceptions for large companies that do not have to pay the EEG levy generally increase energy costs. An increase in local resistance to wind power projects and households' lack of motivation to switch electricity suppliers make it harder for decentralised energy suppliers to compete with larger undertakings. Decentralised actors have so far been unable to establish a strong lobby to put forwards their issues to legislators.

Although the decentralised energy markets developed differently, and the challenges faced differ, German and Japanese stakeholders have set out several common requirements for better framework conditions:

- The market design must be adapted to better meet the special needs of renewables. For example, the burden of bureaucracy should be reduced. In Japan, one case in point are the many regulations governing the granting of development permits for wind and geothermal energy. In Germany, too, complex regulations discourage many companies from investing in renewables;
- Innovative technologies such as energy storage, digitalisation and smart grids should be given stronger political support and higher government subsidies;
- The grid must be expanded to overcome the alleged disadvantages of decentralised systems, such as instability and high costs. In the meantime, all efforts should be made to increase grid flexibility;
- Access to additional capital for transforming the energy system must be guaranteed;

- Horizontal cooperation at the local level should be encouraged. This implies support from local mayors and councillors;
- Public acceptance and the active participation of citizens should be promoted, e.g., by developing suitable participation models;
- Appropriate qualification measures must be provided to ensure that decentralised energy suppliers can recruit sufficient qualified personnel. This also includes the provision of environmental education for students.

DECENTRALISATION IN JAPAN

For decades, the Japanese energy system was centrally organised, and dominated by ten regional energy companies that produced and distributed energy in and for their respective region. Japan's electricity market is currently undergoing an extensive liberalisation process. The market was fully opened in 2016, allowing all customers to obtain energy from suppliers other than the ten original large power producers, paving the way for the monopoly to become a competitive market.

The Japanese grid infrastructure is still divided into ten transmission and distribution sectors (**Figure 1**). Each utility is obliged to manage supply and demand in its service area. 2020 is the target year for the final step of the liberalisation process, which includes disentangling the transmission sector from the distribution sector. **Figure 2** shows the main three stages of the Electricity System Reform.

As a result of this liberalisation, Japan's former energy sector is being challenged. Within the first year of the competitive market, more than 400 new retail companies for electricity had been licensed and the share of consumers switching from the ten major electric power companies to other retail companies had risen to around 6% (almost 3.8 million) [20]. The number of households that have switched to another electricity provider has increased further in the meantime, and is now above 20%. This figure is provided in the latest report by the Organisation for Cross-regional Coordination of Transmission Operators Japan (OCCTO), which regularly collects information from electricity providers and wholesale electricity exchanges [34]. The number of electricity providers is continuously rising, and currently stands at 583 [35].

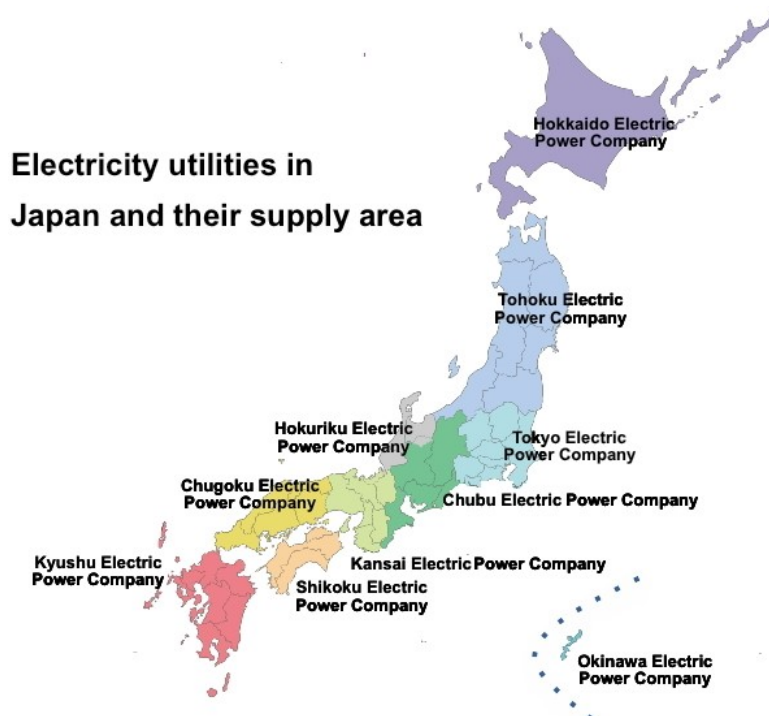


Figure 1. Electricity utilities in Japan (source: own figure, based on the Agency for Natural Resources and Energy [36])

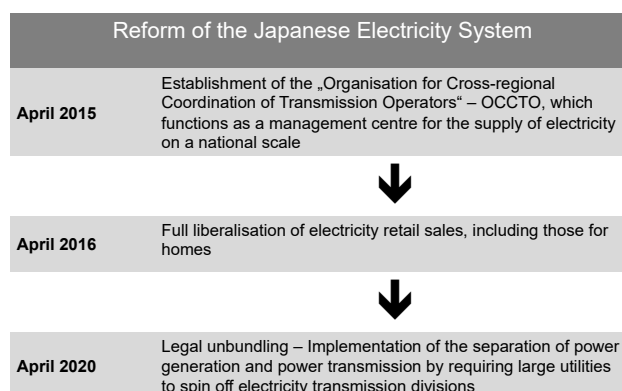


Figure 2. The three stages of the reform of the electricity system in Japan (source: own figure)

Renewables are regarded as an important part of Japan's energy policy, which seeks to address the country's continued high dependence on energy imports and to secure energy supplies. Renewables are also a central cornerstone in the 'Strategic Energy Plan 2018', in which 'efforts for the utilisation of renewable energy as the major power source' are described [37]. In particular, Japan introduced strong policy incentives for solar power with an attractive feed-in tariff in 2012, which led to an increase in PV capacity of about 30 GW between 2010 and 2015, resulting in a 3% growth (30 TWh) in Japan's power supply [38].

Even before the occurrence of the Fukushima disaster, Japan had been discussing the options of introducing a smart grid to integrate renewables, among other things. The reinforcement of interconnection lines was also investigated [39], and attempts made to increase the efficiency of using interconnectors. However, access to the grid is still assigned on a 'first-come, first-serves' basis. This means that providers that are already connected to the grid are given priority, regardless of the type of generating power plant involved [40]. The 'first-come, first-served' method hampers price competition. As a consequence, however, it also means that renewables do not have guaranteed priority access. Furthermore, grid operators are not required to open up the grid to renewables. On the contrary, renewable energy operators must pay for grid enhancement costs, where applicable. It may be necessary to extend the grid as the share of renewables increases, but this would entail high costs and long construction periods.

In contrast to the situation in Germany, the municipal utility movement in Japan is still in its infancy. Nevertheless, a number of pioneering municipalities have emerged, especially since the Fukushima catastrophe. These municipalities are committed to creating a secure and sustainable local-based energy supply from renewable energy sources for their citizens by investing in their own generation facilities and/or by selling renewable electricity generated by other local producers [20]. Moreover, several local governments have recognised the need to become more independent of centrally organised energy supplies from large regional monopolies and of risky nuclear energy. As a result, they have launched projects to promote the decentralised generation of electricity and heat from renewables. The primary objective is to cover local energy needs using locally generated, low-risk and sustainable energy. At the same time, the Ministry of Environment set up a support programme for communities to initiate renewable energy projects [20]. Local authorities saw this as an opportunity to address pressing socio-economic problems such as the ageing population, the growing migration of young people, the lack of jobs and the weakness of the local economy [26]. A total of 250 community power enterprises had emerged by the end of 2016, 50 municipalities in Japan were thought to be fully self-sufficient in renewable energy [20, 41].

In contrast to Germany, however, it is often private companies that established regional energy companies in cooperation with the municipality, in addition to the local administrations themselves. The level of investment participation by the local government varies between

around 5 and 60% [42]. Following the liberalisation of the market, mainly local companies from the gas sector, local cable TV companies and regional infrastructure providers realised the potential of an interesting new business opportunity by establishing ‘Stadtwerke’. The aim was often to compensate for a decline in earnings in their main business areas due to demographic changes. In these cases, the ‘Stadtwerke’ model is regarded as a promising strategy for the successful expansion of business segments [43]. Furthermore, some of Japan’s large, traditional consumer cooperatives (e.g., Seikatsu Club Energy, Palsystem Consumer Cooperative) have entered the power generation and trading market, and are investing in renewables.

They primarily supply their own members, but also other households, with (mainly) sustainably generated electricity. The development of energy cooperatives is also of particular interest in Japan. Such cooperatives are experiencing a similarly dynamic growth in Japan as in Germany.

In Japan, however, local energy companies are entering a market that has very powerful competitors which own the grids and already have a very large customer base due to their decades-long monopoly. Electricity traded on the JPEX electricity exchange accounts for only a very small share of the total quantity of electricity, since most electricity generated is sold via long-term bilateral contracts. As a result, the market is not liquid and prices are too high, which can be a major competitive disadvantage for municipal utilities and other new players in this market [43].

The ‘Japan Stadtwerke Network (JSWNW)’ was established in September 2017. The aim of this network is to foster the exchange of information and the foundation of further regional ‘Stadtwerke’ in Japan. In general, the JSWNW offers support in a wide range of areas, from the organisation of study trips to joint procurement activities and financial planning support [44]. In fact, 32 local municipalities are members of the network. As the model of the German ‘Stadtwerke’ spreads across the country, further decentralisation is likelier to occur [20].

In Japan, the primary goal of setting up a municipal ‘Stadtwerke’ is to supply (a large part of) the municipality or region with energy, especially electricity. Against the backdrop of the Fukushima Daiichi nuclear accident and its far-reaching consequences for electricity supply in Japan, many municipalities are particularly concerned with ensuring a reliable energy supply for the region. Supplies should be as resistant as possible to natural disasters, assisted by a decentralised generation structure based on renewables. The current FIT system is a good way to start mobilising finance towards renewables. In addition, the recent liberalisation of electricity sales draws consumers’ attention to alternatives. In view of the 16 and 25% electricity price increases for households and industry, respectively, in the first two years after the Fukushima catastrophe [38], another goal is to ensure that citizens and companies are supplied with cheap electricity, protecting them from negative effects such as price shocks.

DECENTRALISATION IN GERMANY

The idea of decentralised energy in Germany is by no means a new one. The historically developed central system was criticised at the start of the scientific discussion of the German anti-nuclear movement in the 1980s. Hennicke *et al.* [45] in particular criticised the generation of fossil and nuclear-based power by established energy companies, and defined the term ‘energy transition’ or ‘German Energiewende’ as being one that is very closely related to decentralisation. An important finding of this scientific debate was that a decentralised and democratic corporate structure is an important component for the energy transition towards decarbonised electricity production. Scientists called on municipalities to pursue a new energy policy, emphasising strategies for the remunicipalisation of the energy supply system. The latest developments in renewable energy technology and a strong reduction in costs, combined with a growing awareness at the government and household level [46], are important drivers of the current decentralisation movement. Power generation by the incumbents’ large-scale fossil power plants is decreasing, while the importance of decentralised power plants run by municipal utilities, citizens’ energy companies and households for private consumption is

increasing. The term ‘prosumption’ was coined to describe this phenomenon of the greatest possible decentralisation [46].

In the following, this paper considers two drivers in particular that make an important contribution to the decentralisation of players on the German energy market. The first driver is the considerable increase in the number of energy cooperatives and citizens’ energy companies [47, 48], the second is the phenomenon of new municipal utilities (Stadtwerke) being established [13], [14], [49], [50]. Both trends are of great international interest. This is because decentralisation on the generation side, brought about by the energy transition, has led to a worldwide decentralisation dynamic, posing a major challenge for supply companies and grid operators [24]. At the same time, decentralisation has become an outstanding guiding principle for sustainable and comprehensive quality assurance in the energy supply system. In addition, Germany’s federal system offers great opportunities for developing social and institutional innovations at the municipal level, in keeping with the energy transition [11, 12].

In this context, constitutionally guaranteed local self-administration represents the basis for an active local energy policy [10]. According to the local energy principle, ‘Stadtwerke’ and local energy cooperatives, featuring decentralised structures, are particularly important actors in the implementation of the energy transition. They are deemed key actors in the German Energiewende. We hypothesise that decision-making must be decentralised, alongside the trend towards decentralisation in the area of production. In this sense, the dynamics of the establishment of ‘Stadtwerke’ that have an influence on the local distribution grid and the initiation of local energy cooperatives correspond to polycentric governance.

What role do municipal utilities play in Germany? On the one hand, municipal utilities ensure well over half of the supply of electricity, gas and heat. On the other hand, being local entities, they hold a special position, caught between political, business and private household objectives. Some 900 municipal utilities [51] operate in multiple stages of the value chain in the German energy sector. Together, they manage around 45% of electricity distribution networks in Germany [52]. As such, they make a significant contribution to ensuring a secure supply of electricity to end consumers and create the conditions for renewable energy plants to be able to feed into local distribution networks. In addition, municipal companies have large market shares in the sales sector (the direct supply of end customers with electricity, gas and heat). In 2016, municipal utilities supplied 60% of electricity, 65% of natural gas and 72% of heat in Germany [53]. By operating local and district heating networks, municipal utilities contribute to the heat transition in towns and municipalities. Using their own facilities, ‘Stadtwerke’ generate approximately 84 billion kWh of electricity each year [52]. In 2016, ‘Stadtwerke’ accounted for around 13% of Germany’s gross electricity generation (649.1 billion kWh in total [54]).

In addition, there has been a trend towards remunicipalisation since 2005. By 2016, new municipal utilities had been established in more than 150 German cities [9, 29]. Moreover, hundreds of local electricity and/or gas distribution grids had been taken over from existing municipal utilities [14, 54].

A distinction is made between energy cooperatives and other citizens’ energy companies. Most other energy companies are so-called ‘GmbH & Co. KGs’. This is a hybrid form of a limited liability company (GmbH) and a limited partnership (KG). In the case of ‘GmbH & Co. KGs’, the general partner is not a natural person, but a limited liability company (GmbH), which is liable with its corporate assets. Citizens participate as limited partners, who are partners in a limited partnership (KG). However, the liability of limited partners is usually limited to the amount entered in the commercial register. A variant of the GmbH is the limited liability entrepreneurial company (UG). The establishment of energy cooperatives and other citizens’ energy companies is closely linked to the legal framework in Germany. Promoting the expansion of renewables in particular has led to the decentralisation of the German energy system in recent years. The introduction of the EEG regulated priority feed-in and fixed remuneration for renewable energy. This act created the conditions for predictable payment

flows. Many citizens who participate financially are motivated by non-financial aspects, besides seeking a low-risk investment [56]. Not only private individuals, but also associations of private individuals play a major role. These mergers are primarily set up via registered companies in which citizens act as investors with equity shares. Together, private individuals and citizens' energy companies account for a large share of renewable energy generation in Germany, and have become an international role model [52, 53].

The amendment of the GenG in 2006 led to the biggest increase in the establishment of citizens' energy companies. Figure 3 shows the sharp rise in energy cooperatives in Germany. There were numerous start-ups, especially in the period from 2009 to 2013. 2013 saw the largest number of newly founded companies (totalling 267) [57][58].

The transformation of the energy system in Germany (as anywhere in the world) will undoubtedly be accompanied by the decentralisation of electricity production. This is because the underlying primary energy sources (e.g., solar radiation and wind) are in principle ubiquitous [59]. The social characteristics associated with this fact include a change in actor structures. In society, groups are formed that actively promote the transformation of energy systems, as well as groups that want to prevent it. This confrontation can also trigger local conflict landscapes related to the implementation of the energy transition [4].

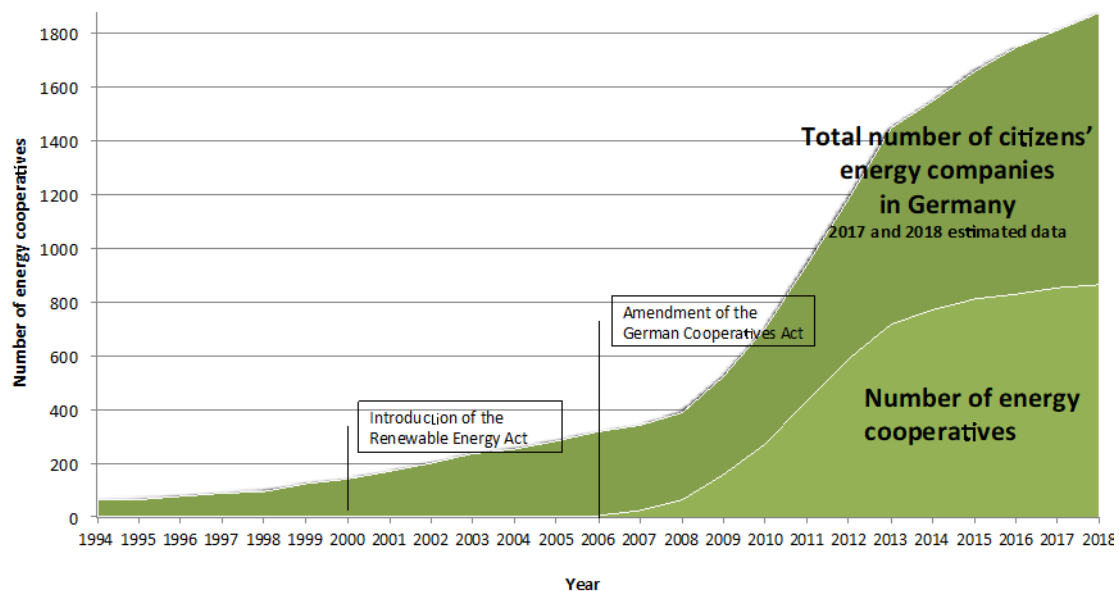


Figure 3. Number of existing energy cooperatives and other citizens' energy companies in Germany between 1994 and 2018 (source: own figure)

DISCUSSION

The starting point for the establishment of community power companies like 'Stadtwerke' differed considerably in Germany and Japan. First of all, municipalities played a different role in the two countries. In the Federal Republic of Germany, many municipalities traditionally owned electricity companies. Many of these survived as 'Stadtwerke', and retained a sense of local ownership. Then market power shifted from 'Stadtwerke' to big utilities. In the course of the electricity market reform, however, the tradition of municipal utilities provided a good basis for the positive acceptance of decentralised renewable energy as a means to partly win back local sovereignty. In contrast, municipalities never played such a role in Japan, which has a centralist government. This is due to the different government structure and the historical development of utility industries [60].

Since community power companies are often closely related to renewables, the development of a country's national energy market also paves the way towards decentralisation. Both countries relied for a long time on nuclear energy. The societal anti-nuclear movement in Germany started at a regional level back in the 1970s. While nuclear

energy was increasingly seen as a risk by large parts of the population in Germany, in Japan it was considered more of a ‘home-grown’ energy source, i.e., a way to avoid import dependencies, and was massively pushed by the government [20]. Phasing out nuclear power in Germany started with an official agreement in 2000. During the phasing-out stage, renewables expanded. The Fukushima Daiichi accident represented a turning point for the energy system in both Japan and Germany. While all nuclear reactors shut down in Japan, it was agreed that all of Germany’s nuclear reactors would be phased out by 2022. A certain share of nuclear energy is to be replaced by renewables. Although the total share of renewables is currently much higher in Germany than in Japan, the timeframe shows that renewables are evolving much more rapidly in Japan.

Overall, the expansion of renewables in Japan is mainly based on cooperative or comparable joint facilities. There is a clear increase in the importance of ‘community power’. The country now has around 250 such companies, which have made a significant contribution to the expansion of renewables [41]. Thanks to their active involvement, the political target of achieving a 22 to 24% share of renewables in the electricity mix by 2030 has almost been met already [61]. As a result, Japan is currently looking in particular for opportunities to integrate these energy cooperatives into a municipal utility ‘Stadtwerke’ model, the number of Japanese ‘Stadtwerke’ is already rising counted [43], [49], [62]. In Germany, such a cooperation model has already been implemented at Stadtwerke Wolfhagen [62].

There are very different definitions of the term ‘citizens energy companies’ in the literature. A variety of terms exist that describe related, overlapping or even the same social phenomena [63]. The literature highlights a total of four characteristics that describe citizens’ energy companies [58]:

- Regionality or locality (community of locality);
- The significance of non-financial goals (mission-driven, social enterprises);
- Openness or representativeness;
- Citizen influence.

These characteristics apply to both Japanese and German community power companies. In Japan, however, much more so than in Germany, the establishment of municipal utilities such as ‘Stadtwerke’ and of decentralised generation units is associated with the ambition of strengthening resilience. The Fukushima Daiichi nuclear accident and its far-reaching consequences for the Japanese electricity supply system greatly exposed the vulnerability of Japan’s energy security [64]. Besides raising awareness of the problem of nuclear energy, the Fukushima accident also increased concerns about supply security [43, 64, 65]. This is because the current Japanese situation is characterised by central and high-risk generation units and a network infrastructure tailored to those units. Japan’s generation structure is therefore set to change considerably in the future. Against this backdrop, the Japanese government’s fifth strategic energy plan sets the goal of building a diversified and flexible energy supply infrastructure [65]. In Japan, the aspect of increasing resilience through decentralised power generation is even more important than in Germany [62] [66]. This is mainly due to its geographical insularity (see Introduction).

Decentralised power generation structures correspond to the principle of a resilient energy supply (Figure 4). Local small solutions, each of which has only a small risk of failure, reduce the risk of the entire system failing. The dispersed spatial distribution of plants and the local characteristics associated with them prevent their simultaneous failure. A high diversification of power sources increases resilience, since dependence on a single source and the risk of a simultaneous failure are relatively low. Electricity from wind, solar, hydropower and biomass enables a power mix that can lead to a balanced supply if an energy source fails to produce any power on account of the weather. The on-site use of natural ‘ubiquitous’ energy also reduces the country’s dependence on fossil fuels [67], in addition, supplies are not threatened by geopolitical conflicts, wars or strikes [68]. Digitalisation of the energy sector enables several

decentralised plants to be combined into virtual power plants. On the demand side, applications can be postponed. In a nutshell, digitalisation can achieve spatial balancing effects that contribute to system stability [69].

Since Japan is an island, it is particularly important that the country is able to provide enough energy to meet its domestic energy needs. In this context, self-sufficiency and the share of renewables in electricity production play a key role. In this connection, self-sufficiency reflects resilience to the interruption of imported energy, the share of renewables reflects the diversity of energy sources. These are very important factors, especially in resource-poor countries like Japan [64].

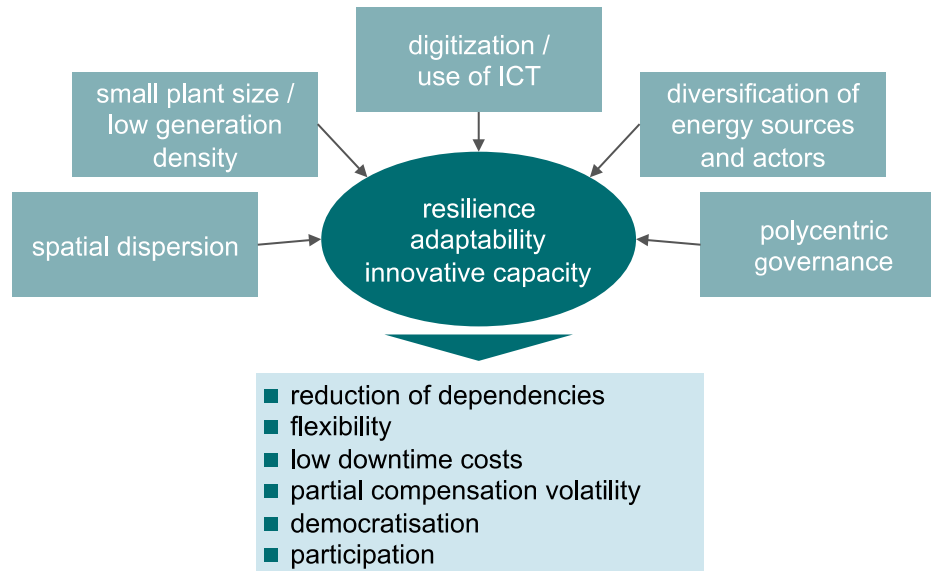


Figure 4. Resilience-enhancing characteristics of decentralised power generation (source: own figure, based on Wiegand [67])

The establishment of many municipal utilities in Germany within the space of a few years' time (Figure 5) caused us to contemplate the reasons for this development. A scoping study conducted by the Wuppertal Institute in 2013 role [4, 70] revealed that the following ten reasons play an important role:

- Achieving environmental objectives and organising the local energy transition;
- Higher local added value;
- Harnessing tax regulations for improving municipal services;
- Improving the income situation of the city;
- Democratisation of supply and stronger orientation towards the common good (public value);
- Creating and protecting good jobs;
- Acting in social responsibility in energy supply;
- Expansion of eco-efficient energy services;
- Harnessing customer relations and public image;
- Materialising synergies with other sectors.

In each case, six external experts from research and practice assessed and evaluated whether a target achievement is possible. According to the findings, a strategy of remunicipalisation offers multifaceted opportunities and benefits to cities and towns that can be used for the local energy transition. The most important reason for this finding is that municipalities are much more committed to expanding renewables than established energy utilities [4].

Although the number of 'Stadtwerke' in Japan is growing, there are many challenges facing new decentralised actors seeking to enter the market. The GJETC Stakeholder Dialogue on Decentralisation led to the identification of the following main challenges:

- Availability of renewable energy sources – does the local area has enough renewable energy potential to supply the community?
- Costs and investment – the period to justify the investment would be quite long (typically 10-20 years or longer) and thus financing can be challenging;
- Interface to the grid – the existing grid may not always appreciate renewable energy, and could block out decentralised actors;
- The grid is still owned by the existing big power companies, but will be separated in 2020. However, even when the grid becomes ‘legally’ separated from the big power companies, the extent to which grid usage will become flexible to accommodate renewables is unclear;
- Most regions where abundant renewable energy sources exist are experiencing a decrease in population. By the time renewables are able to offer sufficient economic benefits to the local community, there will be too few consumers in the region to sustain the decentralised actors.

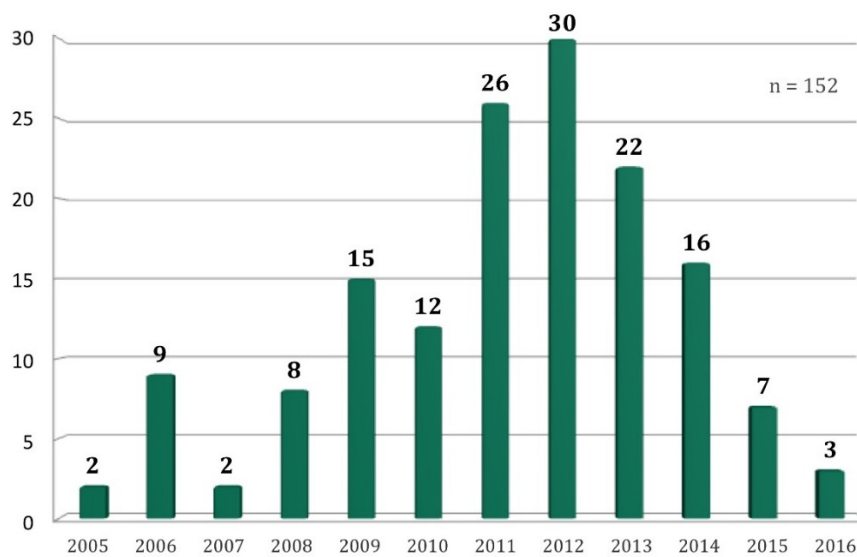


Figure 5. Start-ups of municipal energy suppliers in Germany between 2005 and 2016 [9] (source: own figure)

Nevertheless, the GJETC Stakeholder Dialogue on Decentralisation found that the benefits of ‘Stadtwerke’ foundations outweigh the challenges. It is acknowledged that decentralised actors improve local communities’ energy independence from existing centralised big energy suppliers. To achieve this goal, decentralised actors must develop renewable energy potentials in the region to maximise the economic benefits to the local community. The benefits to the local community created by decentralised actors are as follows:

- Economic benefits to the local community due to;
 - Reduced energy payments to external companies;
 - The creation of new jobs by the decentralised actor companies;
- Development of an entrepreneurial mindset in the local community, driven by the decentralised actor companies.

The challenges facing new decentralised actors in Japan are different, and probably also greater than those faced by German actors. However, German stakeholders have also mentioned difficulties caused by renewables being treated unequally or by the market design being inappropriate for renewables. The benefits of a decentralised electricity market are similar in Japan and Germany: stakeholders from both countries particularly mentioned local job creation, added local value and independence from big utilities.

CONCLUSION AND OUTLOOK

A characterising feature of the Japanese and the German energy transition is that it started as a movement arising from civil society. In both countries, the nuclear disaster at the Fukushima Daiichi nuclear power plant not only debunked the safety myth of nuclear power, but also the traditional centralised electricity system itself. It also weakened confidence in the incumbents of the energy industry. Instead, there was a growth in the importance of decentralisation and regional added value in the form of locally based renewables, the promotion of resilience, social services, and citizen funding. Local renewables and local measures to increase energy efficiency not only generate local profit, income and tax revenues, but also create a ‘citizen value’ that can help enhance and revitalise a local area.

The paths taken by the two countries differ in detail, but there is a distinct trend towards decentralisation: the energy transition in Japan is as much a reality as in Germany. In both countries, external factors, especially the Fukushima Daiichi accident, played a major role in the establishment of decentralised community-based renewable energy systems. While this development took much longer in Germany, Japan’s energy system moved from a highly centralised set-up to a much more decentralised one within a very short space of time. Japan has not yet reached Germany’s level of decentralisation, but its rate of change is very fast.

Time is one aspect in which the two countries differ: the operation of municipal utilities (Stadtwerke) has a much longer tradition in Germany and, with around 1,000 municipal companies, is much more important than in Japan. In addition, German municipal utilities have been active in all energy-related stages of the value chain (generation, local grid operation, sales and the provision of services) for many years. A characteristic feature of ‘Stadtwerke’ is the pronounced decentralisation of electricity generation and distribution. It is therefore not surprising that municipal utilities in Germany are among the key players in the energy transition process. In Japan, on the other hand, a noticeable trend towards decentralisation has only been observed for a few years. At least in many respects, Germany is still a role model for Japan when it comes to decentralisation. Not least the establishment of the Japan Municipal Utility Network (JSWNW) in 2017 shows how intensively alternatives to the central energy supply system are being considered in that country. It is also remarkable in this context that the German word ‘Stadtwerke’ has found its way into the Japanese language.

The legal disentanglement of power generation and power transmission will be implemented in Japan in 2020. This development may offer additional opportunities for the establishment of municipal utilities. What can already be ascertained is that, not only the ‘more recent’ Japanese decentralisation movement, but also the ‘more established’ German version represent suitable framework conditions for facilitating successful transformation processes.

ACKNOWLEDGMENT

We would like to thank the GJETC and its members and secretariats for organising and, above all, participating in the stakeholder dialogues. We thank the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety of the Federal Republic of Germany and the Ministry of the Environment, Government of Japan, for financing and supporting our studies. We also thank Dr. Kurt Berlo and Professor Dr. Peter Henicke for their valuable input. We would like to thank Dr. Jörg Raupach-Sumiya for providing essential insights into the development of Japanese ‘Stadtwerke’. We are also grateful to representatives from Aizu Electric Power, Miyama Smart Energy, Nakanajo-Power Co., NTT Data Institute of Management Consulting, Ohisama Shinpo and METI-Kansai for sharing their views on a decentralised energy system in Japan, and to representatives from EWS Schönau, Heidelberger Energiegenossenschaft, proKlima, Naturstrom, Solarcomplex, Stadtwerke Union Nordhessen and Stadtwerke Speyer for their views on a decentralised energy system in Germany.

REFERENCES

1. S. Becker, C. Kunze, und M. Vancea, „Community energy and social entrepreneurship: Addressing purpose, organisation and embeddedness of renewable energy projects“, *Journal of Cleaner Production*, Bd. 147, S. 25–36, 2017, <https://doi.org/10.1016/j.jclepro.2017.01.048>.
2. G. Fuchs und N. Hinderer, „Towards a low carbon future: a phenomenology of local electricity experiments in Germany“, *Journal of Cleaner Production*, Bd. 128, S. 97–104, Aug. 2016, <https://doi.org/10.1016/j.jclepro.2016.03.078>.
3. F. W. Geels u. a., „The enactment of socio-technical transition pathways: A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990–2014)“, *Research Policy*, Bd. 45, Nr. 4, S. 896–913, Mai 2016, <https://doi.org/10.1016/j.respol.2016.01.015>.
4. K. Berlo, O. Wagner, und M. Heenen, „The incumbents’ conservation strategies in the German energy regime as an impediment to re-municipalization: an analysis guided by the multi-level perspective“, *Sustainability*, Bd. 9, Nr. 1, 2017.
5. T. Hoppe und G. de Vries, „Social Innovation and the Energy Transition“, *Sustainability*, Bd. 11, Nr. 1, S. 141, Dez. 2018, <https://doi.org/10.3390/su11010141>.
6. R. J. Hewitt u. a., „Social innovation in community energy in Europe: a review of the evidence“, SocArXiv, preprint, Okt. 2018. <https://doi.org/10.31235/osf.io/hswzg>.
7. D. Süsser, M. Döring, und B. M. W. Ratter, „Harvesting energy: Place and local entrepreneurship in community-based renewable energy transition“, *Energy Policy*, Bd. 101, S. 332–341, Feb. 2017, <https://doi.org/10.1016/j.enpol.2016.10.018>.
8. M. Gancheva, S. O’Brien, N. Crook, C. Monteiro, und Europäischer Ausschuss der Regionen, *Models of local energy ownership and the role of local energy communities in energy transition in Europe*. 2018.
9. K. Berlo, D. Schäfer, und O. Wagner, Mitmischen is Possible: Newly Founded Municipal Utilities Take Advantage of the Opportunities Offered by the Energy Transition (in German), *Energiewirtschaftliche Tagesfragen*, Bd. 67, Nr. 12, S. 96–99, 2017.
10. M. A. Schreurs, „From the Bottom Up: Local and Subnational Climate Change Politics“, *The Journal of Environment & Development*, Bd. 17, Nr. 4, S. 343–355, 2008, <https://doi.org/10.1177/1070496508326432>.
11. E. Gawel u. a., „The future of the energy transition in Germany“, *Energy, Sustainability and Society*, Bd. 4, Nr. 1, S. 15, 2014, <https://doi.org/10.1186/s13705-014-0015-7>.
12. D. Ohlhorst, K. Tews, und M. Schreurs, Energy Transition as a Challenge for Coordination in the Multi-Level System, *Technology Assessment – Theory and Practice*, (in German), Bd. 22, Nr. 2, S. 48–55, 2013.
13. O. Wagner und K. Berlo, „Remunicipalisation and foundation of municipal utilities in the German energy sector: details about newly established enterprises“, *Journal of sustainable development of energy, water and environment systems*, Bd. 5, Nr. 3, S. 396–407, 2017.
14. K. Berlo und O. Wagner, "New Municipal Utilities and Re-Municipalisations – Energy Supply in Municipal Responsibility" (in German), Wuppertal Institut, Wuppertal, September, 2013. [Online]. Verfügbar unter: http://wupperinst.org/uploads/tx_wupperinst/Stadtwerke_Sondierungsstudie.pdf.
15. S. Kishimoto, O. Petitjean, und L. Steinfort, *Reclaiming Public Services: How cities and citizens are turning back privatisation*. Amsterdam and Paris: Transnational Institute (TNI), Multinationals Observatory, Austrian Federal Chamber of Labour (AK), European Federation of Public Service Unions (EPSU), Ingeniería Sin Fronteras Cataluña (ISF), Public Services International (PSI), Public Services Intern, 2017.
16. D. Hall, E. Lobina, und T. Philip, „Re-municipalising municipal services in Europe“, PSIRU, Business School, University of Greenwich, London, U.K., 2012.
17. M. Sugiyama u. a., „Japan’s long-term climate mitigation policy: Multi-model assessment and sectoral challenges“, *Energy*, Bd. 167, S. 1120–1131, Jan. 2019, <https://doi.org/10.1016/j.energy.2018.10.091>.
18. R. J. Samuels, *3.11 - Disaster and Change in Japan*, First Edition. Ithaca, United States: Cornell University Press, 2013.
19. P. Hennicke und P. J. J. Welfens, *Energiewende nach Fukushima: deutscher Sonderweg oder weltweites Vorbild?* München: Oekom-Verl., 2012.
20. I. Wiczorek, „Energy Transition in Japan: From Consensus to Controversy“, S. 12.

21. O. Renn und J. P. Marshall, „Coal, nuclear and renewable energy policies in Germany: From the 1950s to the “Energiewende”“, *Energy Policy*, Bd. 99, S. 224–232, Dez. 2016, <https://doi.org/10.1016/j.enpol.2016.05.004>.
22. K. Oshiro, M. Kainuma, und T. Masui, „Implications of Japan’s 2030 target for long-term low emission pathways“, *Energy Policy*, Bd. 110, S. 581–587, Nov. 2017, <https://doi.org/10.1016/j.enpol.2017.09.003>.
23. O. Pao-Yu u. a., „Phasing out coal in the German energy sector : interdependencies, challenges and potential solutions“, German Institute for Economic Research (DIW Berlin), Berlin, 2019. [Online]. Verfügbar unter: <http://nbn-resolving.de/urn:nbn:de:bsz:wup4-opus-72655>.
24. M. Kubli und S. Ulli-Beer, „Decentralisation dynamics in energy systems: A generic simulation of network effects“, *Energy Research & Social Science*, Bd. 13, S. 71–83, 2016, <https://doi.org/10.1016/j.erss.2015.12.015>.
25. J. M. Weinand, R. McKenna, und W. Fichtner, „Developing a municipality typology for modelling decentralised energy systems“, *Utilities Policy*, Bd. 57, S. 75–96, 2019, <https://doi.org/10.1016/j.jup.2019.02.003>.
26. H. Hamanaka, „Community Projects in Japan: Challenges and opportunities for realizing the potential as a strong driver for energy transition, climate policies and local community revitalization“, gehalten auf der German-Japanese Symposium, Tokyo, Nov. 02, 2016.
27. K. Hübner, „Municipally Oriented Business Models for Sustainable Power Supply in Japan" (in German), TU Berlin, Berlin, Germany, 2017.
28. J. Libbe, „Transformation of Urban Infrastructure – Perspectives and Elements of Municipal Transition Management using the Example of Energy" (in German), Dissertation, Universität Leipzig, 2014.
29. K. Berlo, D. Schäfer, und O. Wagner, „Stadtwerke Start-ups in Germany: A Balance Sheet of the Period of Expiring Concession Contracts for Local Electricity and Gas Distribution Grids" (in German), *Planung neu denken online*, Nr. 1, 2018, [Online]. Verfügbar unter: <http://nbn-resolving.de/urn:nbn:de:bsz:wup4-opus-69333>.
30. D. Schäfer, „The Importance of Local Utilities as Actors in the Energy Transition“ (in German), Master Thesis, Wuppertal Institut für Klima, Umwelt, Energie, Wuppertal, 2017.
31. E. Cuppen, „Diversity and constructive conflict in stakeholder dialogue: considerations for design and methods“, *Policy Sciences*, Bd. 45, Nr. 1, S. 23–46, März 2012, <https://doi.org/10.1007/s11077-011-9141-7>.
32. E. Schramm, Stakeholder Involvement to Tackle Biodiversity Conflicts (in German), A Guide, Biodiversity and Climate Research Center (BiK-F), 2012.
33. R. E. Freeman, J. S. Harrison, und S. Zyglidopoulos, *Stakeholder Theory: Concepts and Strategies*. Cambridge University Press, 2018.
34. Kurishima, Oikawa, Takezawa, Press Release by the Japanese Ministry of Economy Trade and Industry of 14 December 2018, Electric Power Switching Rate (Between Operators/Within Operators, Low Voltage) Exceeded 20% (in Japanese), Tokyo, Japan, 2018, <https://www.meti.go.jp/press/2018/12/20181214004/20181214004.html>, [Accessed: 22-April-2019].
35. Yamada, Kamakura S., Press Release by the Japanese Ministry of Economy Trade and Industry of 21 December 2018, Registered Retail Electricity Supplier (Registered on 21 December 2018) (in Japanese), Tokyo, Japan, 2018, <https://www.meti.go.jp/press/2018/12/20181221006/20181221006.html>, [Accessed: 22-April-2019].
36. S. Agency for Natural Resources and Energy (JCN 3000012090002) , „Full liberalization of the electricity market“, *What does liberalization of the electricity market mean?*, Dez. 21, 2018. https://www.enecho.meti.go.jp/en/category/electricity_and_gas/electric/electricity_liberalization/what/ (zugegriffen Apr. 22, 2019).
37. Ministry of Economy, Trade and Industry (METI), „5th Strategic Energy Plan“. Juli 2018, [Online]. Verfügbar unter: https://www.enecho.meti.go.jp/en/category/others/basic_plan/5th/pdf/strategic_energy_plan.pdf.
38. International Energy Agency (IEA), Organisation for Economic Co-operation and Development, Energy Policies of IEA Countries, 2016, <https://www.iea.org/subscribe-to-data-services/energy-policies-data>, [Accessed: 28-April-2020].

39. H. Asano, „Electricity Grid Infrastructure“, in *Energy Technology Roadmaps of Japan: Future Energy Systems Based on Feasible Technologies Beyond 2030*, Y. Kato, M. Koyama, Y. Fukushima, und T. Nakagaki, Hrsg. Tokyo: Springer Japan, 2016, S. 185–195.
40. Matschoss, Iinuma et. al, „New Allocation of Roles and Business Segments of Established and new Participants in the Energy Sector Currently and Within a Future Electricity Market Design“. GJETC, Nov. 28, 2017, [Online]. Verfügbar unter: http://www.gjetc.org/wp-content/uploads/2017/12/GJETC_ST3_New-allocation-of-roles-and-business-segments-of-established-and-new-participants-in-the-energy-sector.pdf.
41. T. Iida, „Community power in Japan“, gehalten auf der Briefing Meeting, German Stadtwerke Mission to Japan @German Institute for Japanese Studies, Tokio, Sep. 10, 2018.
42. S. Hayashi, S. Tominaga, und K. Yatsuka, "Involvement of the Local Government in the Local Production for Local Consumption of Energy: Case Consideration of Local Energy Companies, Including the City of Kitakyushu", Institute for Global Environmental Strategies, Kitakyushu, [1]–[4] Japan, 2016, https://www.iges.or.jp/en/publication_documents/pub/issue/en/5487/Involvement_of_the_Local_Government_in_the_Local_Production_for_Local_Consumption_of_Energy_EN.pdf, [Accessed: 28-April-2020]
43. O. Wagner, V. Aydin, K. Berlo, N. Gericke, P. Hennicke, und M. Venjakob, „Status and New Foundations of Municipal Utilities: Germany and Japan in Comparison, Input Paper on the Capacity Building Project for Decentralised Energy Supply Actors in Japan" (in German), Wuppertal Inst. für Klima, Umwelt, Energie, Wuppertal, Working Paper, 2018. [Online]. Verfügbar unter: <http://nbn-resolving.de/urn:nbn:de:bsz:wup4-opus-70108>.
44. J. Raupach-Sumiya, „Birth of Japanese version of “Stadtwerke” –The aims and social economic significance (Municipality-owned utilities in Japan - Their purpose and social-economic implications)“, gehalten auf der Kyushu University Energy Week 2018 Chikushi Symposium, Chikushi Hall, C-Cube 1F, Chikushi Campus, Kyushu University (6-1 Kasuga-koen, Kasuga, Fukuoka 816-8580, Japan), Feb. 01, 2018, [Online]. Verfügbar unter: http://cr.cm.kyushu-u.ac.jp/doc/EnergyWeek2018_Chikushi_E.pdf.
45. P. Hennicke, J. P. Johnson, S. Kohler, und D. Seifried, "*The Energy Transformation is Possible: For a New Energy Policy of the Municipalities, Strategies for Re-Municipalization*" (in German). Frankfurt am Main: S. Fischer, 1985.
46. A. Hope, T. Roberts, und I. Walker, „Consumer engagement in low-carbon home energy in the United Kingdom: Implications for future energy system decentralization“, *Energy Research & Social Science*, Bd. 44, S. 362–370, Okt. 2018, <https://doi.org/10.1016/j.erss.2018.05.032>.
47. Ö. Yildiz u. a., „Renewable energy cooperatives as gatekeepers or facilitators? Recent developments in Germany and a multidisciplinary research agenda“, *Energy Research & Social Science*, Bd. 6, S. 59–73, 2015, <https://doi.org/10.1016/j.erss.2014.12.001>.
48. S. Debor, „The socio-economic power of renewable energy production cooperatives in Germany : results of an empirical assessment“, Wuppertal Institute for Climate, Environment and Energy, Wuppertal, 2014.
49. S. Kishimoto, O. Petitjean, und L. Steinfort, *Reclaiming Public Services : How cities and citizens are turning back privatisation*. Amsterdam and Paris: Transnational Institute (TNI), Multinationals Observatory, Austrian Federal Chamber of Labour (AK), European Federation of Public Service Unions (EPSU), Ingeniería Sin Fronteras Cataluña (ISF), Public Services International (PSI), Public Services Intern, 2017.
50. S. Becker, R. Beveridge, und M. Naumann, „Remunicipalization in German cities: contesting neo-liberalism and reimagining urban governance?“, *Space and Polity*, Bd. 19, Nr. 1, S. 76–90, 2015, <https://doi.org/10.1080/13562576.2014.991119>.
51. VKU, „Energy Transition | Our Topics | Association of Municipal Companies Registered Association 2018 (in German)“, Berlin, Germany, 2018, <https://www.vku.de/themen/energiewende/>, [Accessed: 07-August-2018].
52. Verband Kommunaler Unternehmen (VKU) „Figures, Data, Facts 2018 (in German), Berlin, Germany, 2018, <https://www.vku.de/publikationen/2019/zahlen-daten-fakten-2018/>, [Accessed: 28-April-2020].
53. Verband Kommunaler Unternehmen (VKU), „The Municipal Letter “11011” Berlin (in German), Berlin, Germany, 2018, <https://www.vku.de/publikationen/2018/der-kommunalbrief-11011-berlin-ausgabe-juli-2018/>, [Accessed: 07-August-2018].

54. Umweltbundesamt, „Renewable and Conventional Power Generation" (in German), Vienna, Austria, 2018, <http://www.umweltbundesamt.de/daten/energie/stromerzeugung-erneuerbar-konventionell>, [Accessed: 07-August-2018].
55. K. Berlo, C. Herr, O. Wagner, und M. Companie, „Explorative Study on Success Potentials of Newly Founded Municipal Utilities: An Exploratory Study on Municipal Energy Supply, Results of a Survey of Newly Founded Municipal Utilities in the Energy Sector (in German), Wuppertal Institute for Climate, Environment and Energy, Wuppertal, Germany, 2018. <http://nbn-resolving.de/urn:nbn:de:bsz:wup4-opus-71566>. [Accessed: 07-August-2018]
56. L. Holstenkamp und F. Kahla, „What are community energy companies trying to accomplish? An empirical investigation of investment motives in the German case“, *Energy Policy*, Bd. 97, S. 112–122, 2016, <https://doi.org/10.1016/j.enpol.2016.07.010>.
57. F. Kahla, „The Phenomenon of Citizens' Energy in Germany, A Business Analysis of Civil Societies in the Field of Renewable Energy Production" (in German), *Ph.D. Thesis*, Leuphana University of Lüneburg, Lüneburg, Germany, 2018.
58. F. Kahla, L. Holstenkamp, J. Müller, und H. Degenhart, Development and Status of Citizens' Energy Companies and Energy Cooperatives in Germany (in German), Working Paper Series in Business and Law, Leuphana University of Lüneburg, Lüneburg, Germany, 2017, <https://doi.org/10.13140/RG.2.2.19726.46407>.
59. L. Gailing und A. Röhring, „What Are the Decentralised Aspects of the Energy System Transformation? Infrastructures of Renewables as Challenges and Opportunities for Rural Areas (in German), *Raumforschung und Raumordnung*, Vol. 73, pp 31-43, 2015, <https://doi.org/10.1007/s13147-014-0322-7>.
60. I. of E. E. J. Wuppertal Institut, „GJETC Report 2018. Intensified German-Japanese Cooperation in Energy Research: Key Results and Policy Recommendations“. 2018, [Online]. Verfügbar unter: <http://www.gjetc.org/wp-content/uploads/2018/04/GJETC-Report-2018.pdf>.
61. K. Kimura, „Japan's Climate and Energy Policy, problems and bottlenecks“, gehalten auf der German Stadtwerke Mission to Japan - Briefing Meeting, Deutsches Institut für Japanstudien, Tokio, Sep. 10, 2018.
62. K. Berlo und O. Wagner, „Keyword: Deutsche Stadtwerke as a Role Model for Japan" (in German), *E|n|w Energie Markt Wettbewerb*, Essen, Germany, 2016, <https://epub.wupperinst.org/frontdoor/index/index/docId/6313>, [Accessed: 28-April-2020].
63. L. Holstenkamp, „Introductory Remarks on the Country Comparison, Definition of Citizens' Energy, Country Selection and Overview of Funding Mechanisms" (in German), in: *Handbook on the Energy Transition and Participation* (in German), Springer Fachmedien Wiesbaden, 2018.
64. R. Yamanishi, Y. Takahashi, und H. Unesaki, „Quantitative Analysis of Japan's Energy Security Based on Fuzzy Logic: Impact Assessment of Fukushima Accident“, *Journal of Energy*, Bd. 2017, S. 14, 2017.
65. „Fifth Strategic Energy Plan“, Government of Japan, Ministry of Economy, Trade and Industry, Tokyo, Strategic Energy Plan, Juli 2018. Zugegriffen: Feb. 15, 2019. [Online]. Verfügbar unter: http://www.enecho.meti.go.jp/en/category/others/basic_plan/5th/pdf/strategic_energy_plan.pdf.
66. M. Esteban und J. Portugal-Pereira, „Post-disaster resilience of a 100% renewable energy system in Japan“, *Energy*, Bd. 68, S. 756–764, Apr. 2014, <https://doi.org/10.1016/j.energy.2014.02.045>.
67. J. Wiegand, „Decentralised Power Generation as an Opportunity to Strengthen Energy Resilience: A Qualitative Analysis of Municipal Strategies in the Unna Region" (in German), *Bachelor's Thesis*, University of Cologne, Köln, Germany, 2017.
68. S. Erker, R. Stangl, und G. Stoeglehner, „Resilience in the light of energy crises – Part I: A framework to conceptualise regional energy resilience“, *Journal of Cleaner Production*, Bd. 164, S. 420–433, Okt. 2017, <https://doi.org/10.1016/j.jclepro.2017.06.163>.
69. C. Synwoldt, *Decentralised Energy Supply with Renewables* (in German), Springer Vieweg, Wiesbaden, Germany, 2016.
70. K. Berlo und O. Wagner, „The Wave of Remunicipalisation of Energy Networks and Supply in Germany: the Establishment of 72 New Municipal Power Utilities“, *ECEEE Summer Study Proceedings*, S. 559–569, 2015



Paper submitted: 07.12.2019
Paper revised: 28.04.2020
Paper accepted: 02.05.2020