

Regional and Municipal Levels – the Central Arenas of the Energy Transition in Germany

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Abstract

The energy transition can be mapped on four levels. While industry and the state should act on the national and international level, most of the energy transition is taking place at the regional and municipal levels. Here the small-scale and decentralized nature of the new energy world is reflected, where customized individual solutions are created.

Characteristics of the new energy world

The energy transition is much more than just replacing fossil fuels and uranium with renewable energies. The 4th industrial revolution is fundamentally changing the energy world. The new energy world will be essentially characterized by

- decentralized, distributed structures,
- regenerative energies, and
- intelligent systems.

It is true that there will continue to be large structures, such as offshore wind farms, large photovoltaic plants in sunny countries, international distribution grids, or cross-border hydrogen infrastructure. The new energy world, on the other hand, will be characterized by many small-scale, on-site solutions: decentralized energy supply in urban neighborhoods, individual energy generation through photovoltaics and windmills, community energy systems in business parks, and the interconnection of decentralized systems to virtual power plants, smart grids, and much more.

The large structures are already dominated by large companies and concerns. They have embraced the energy transition and are driving the generation of electricity from renewable sources, the replacement of fossil energy in industrial processes and the hydrogen infrastructure [2].

However, these large-scale industrial structures require a different market-economy framework and different regulatory regimes than the newly emerging small-

scale and decentralized structures. Nevertheless, the energy transition is still considered as a whole, which leads to conflicts and contradictions.

The four action levels of the energy transmission

The high complexity and diversity of the fields of action is a great challenge for many actors in the energy world and also for politics and citizens. The elements are interconnected in many ways and influence each other, which often seems to lead to contradictions and oppositions. The difficulty in understanding this complexity is often the reason for a skeptical or negative attitude towards the energy transition.

This complexity can be reduced if the energy transition is not viewed as a whole, but if it is mapped on four levels: *international, national, regional* and *individual* (see Figure 1) [3].

Responsibility for action at the various levels should lie with different bodies. Municipal utilities, local authorities and public transport operators know what the framework conditions and requirements are at their regional level. Companies and private house-

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Level	Change	Characteristics	Fields of action
 International	Change of responsibility	<ul style="list-style-type: none"> • Energy as a global common good • International energy partnerships • Congruent energy and foreign policy 	<ul style="list-style-type: none"> • Global networking to reduce greenhouse gases • Technology dissemination • International hydrogen economy • Capital / financing systems
 National	Energy and technology change	<ul style="list-style-type: none"> • Renewable energies instead of fossil fuels and uranium • Electrification of the systems • Large wind and solar parks • Control of power distribution 	<ul style="list-style-type: none"> • Expansion of more solar and wind parks • Compensation of volatilities / flexible grid control • Technology promotion • National hydrogen economy
 Regional	Paradigm change	<ul style="list-style-type: none"> • Decentralization • Distributed systems • Intelligent systems • Transparency of energy systems • Regional actors • Citizen involvement/participation 	<ul style="list-style-type: none"> • Energy availability • Balancing supply and demand • Regional multidirectional actor networks • SMEs as market participants • Urban district supply • Mobility concepts
 Individual	Change of attitude	<ul style="list-style-type: none"> • Solar and wind energy as a public good • Prosumer / self-sufficiency • Energy value defined by availability • Individual responsibility • Conscious use of energy / experiencing energy 	<ul style="list-style-type: none"> • Strengthening decentralized structures and forms of organization • Energy platforms • Small-scale energy partnerships • Rediscovering energy as a production factor

Figure 1: The four levels of the energy transition, the characteristics of the respective change and the fields of action (Gochermann 2021).

holds want to and should determine for themselves how they deal with energy. And policymakers must set framework conditions at the national level, coordinate technologies at a higher level and reach international agreements. As long as one stays on one level, there is usually no conflict.

It becomes problematic when you move across levels: when large national energy companies want to control energy all the way into the home, when municipal utilities or regional players act on the national or even international stage, or when the state wants to regulate all the way down to the individual level. The energy transition in Germany threatens to be stifled in over-regulation by the state, in too detailed thinking and in the definition of individual regulations and individual exceptions. In organizational theory, this is called over-organization.

In its 2018 report on the “Coordination and management of the implementation of the energy transition in Germany” the German Federal Court of Audit sharply criticized such over-organization. According to the report, the tasks of the energy turnaround are spread across four departments with 38 units and almost 300 employees in the Federal Ministry of Economics alone, plus around 400 employees in subordinate authorities [4]. The Federal Audit Office doubted the control function of the 26 laws and 32 ordinances that regulated the generation, storage, transmission, distribution and consumption of energy “in some cases with a high degree of detail.”

Energy transition takes place at the regional level

Politicians in Germany, and certainly in other industrialized countries, still assume that the energy transition has to happen at the national level. From the perspective of the Ministry of Economics, energy policy is still primarily industrial policy. They only think in terms of large industrial structures, large power lines and regulation of the system.

However, only part of the energy transition is taking place at the national level. It is essentially an energy and technology transformation. The switch from coal and uranium to renewables is indeed a national task. The phase-out of nuclear energy and also of coal were important national decisions in Germany. But regulating how and where distributed and volatile renewables develop and how they are integrated into the system cannot be controlled by a ministry.

The main level at which the energy transition is taking place is the regional level. Until now, it was purely a distribution level for energy suppliers, including the necessary infrastructure. Municipal utilities and energy supply companies *supplied* the end users with electricity, gas and heat.

Today, the regional level is already the playing field on which the energy transition is being driven forward. And it will be even more so in the future with increasing decentralization, distributed systems, and the multitude of new players. There are a wide variety of players on the playing field: cities and municipalities, municipal utilities and public transport companies, citizens' energy cooperatives and medium-sized companies,

neighborhood operators and regional energy companies, and many more. In addition, there are all the actors at the individual level who either use energy or want to produce it and feed it into the grid. The coordination between all these actors can only take place at the regional level. This is where the picture of the new energy world is shaped.

Ultimately, it is a question of regional services of general interest, but not as a supply obligation of a few companies, as has been up to now. Regional services of general interest in the energy sector mean connecting the individual and regional levels in the sense of platforms and creating the conditions for dynamic exchange and cooperation.

Completely new tasks and opportunities are emerging for regional municipal utilities and energy companies. They are no longer pure suppliers, but rather the moderators of the networked energy world. They provide the platforms, ensure the availability of energy through flexible balancing, and adapt the necessary concepts to the respective regions.

Municipal utilities as infrastructure service providers

The municipal utility Wuppertaler Stadtwerke (WSW) is more than just a distribution network operator and energy supplier. The WSW group of companies has the character of a concern and, in addition to WSW Energie & Wasser AG, also includes the local transport division WSW Mobil GmbH and the waste management company Abfallwirtschaftsgesellschaft mbH. According to CEO Markus Hilkenbach, the orientation is that of a local infrastructure service provider.

The aim is to organize services relating to public utilities in such a way that customers can purchase everything with a single customer number. Be it electricity, gas or heat, energy services, but also the mobility offers [5]. In the future, comprehensive services will be offered in the areas of network and distribution, smart city, telecommunications, intelligent systems and platform economy, as well as waste disposal. Linking all these offerings enables the formation of a “municipal nucleus” that represents a genuine unique selling proposition.

District development and sector coupling

Municipal utilities can also take a leading role in sector coupling at the municipal level. Wuppertaler Stadtwerke (WSW) has long been intensively pursuing the topics of neighborhood development, heat transition and mobility transition. Together with the University of Wuppertal, WSW is involved, for example, in the Arrenberg climate quarter [6], where new approaches of living together have been tested for over 25 years - far beyond questions of energy use. In a research project, hundreds of apartments in a densely populated, historic working-class neighborhood were equipped with smart meters. One goal was to study tenants' willingness to shift their own energy use patterns in “sync” with the volatile supply of renewables. The results are

impressive. By load shifting alone, significant CO₂ savings were realized in the households.

The publicly funded “Wuppertal Model”, which closes the chain from waste incineration and the generation of heat and electricity, through the local production of hydrogen, to the refueling of the company’s own hydrogen buses, acts beyond the country’s borders as a blueprint for comparable projects in Germany, but also in Canada.

Shaping the urban heat transition

In cities, there is considerable local heat potential, such as commercial waste heat, wastewater heat, geothermal heat, solar energy and, depending on the location, river water heat. According to the Institute for Ecological Economy Research (IÖW) in Berlin, municipalities should definitely tap into this potential. In the medium term, this could reduce the demand for gas for heating. It would be efficient and cost-effective to tap the potential not only where it occurs, but as comprehensively as possible. In most cases, this would only be possible with a cross-building district approach [7].

In 2019, the management consultancy Ernst & Young (EY) conducted a study on heating sales in which around 600 private customers were asked about their needs and experiences with decentralized heating solutions, as well as their relationships with energy suppliers and other participants active in the heating market [8]. In contrast to the electricity market, the heating market has always been characterized by its decentralized nature, as the transport of heat is much more lossy than electricity. The heating market is characterized by a large number of suppliers offering a wide range of additional services in addition to the spectrum of generation technologies described above. However, only very few providers cover this total scope of technologies and services for all customer groups. The majority of market players, mostly smaller craft enterprises, limit themselves to a selected number of technologies and services.

Regional concepts - energieland2050

The majority of renewable energy generation facilities in Germany are located in rural areas. For thirty years now, rural areas have been a pioneer in renewables. The Steinfurt district in the Münsterland region of northwestern Germany, approx. 450,000 inhabitants, has been committed to climate protection for more than 20 years. It is one of the few counties that has its own office for climate protection and sustainability.

In addition to the municipal district activities, a network has been formed in the district of Steinfurt over the last 15 years in which more than 80 companies and all 24 municipalities want to promote climate protection. In the meantime, these activities have been brought together in an association, the *energieland2050* [9]. In 2050, according to the objective, the district wants to be energy self-sufficient and independent. To achieve this, the consumption of energy is to be reduced by 50 percent. The potential of renewable energies is to be fully exploited, and the volume of wind power is to be at least maintained by re-powering the old plants [10]. The first large wind farm in Germany was built in the mid-1990s in the municipality of Schöppingen - in the district of Steinfurt [3, p. 222]. Today the share of renewable energies in electricity consumption in the Steinfurt district is almost 70 percent. There are 21 wind farms in the region, and around 4,000 citizens

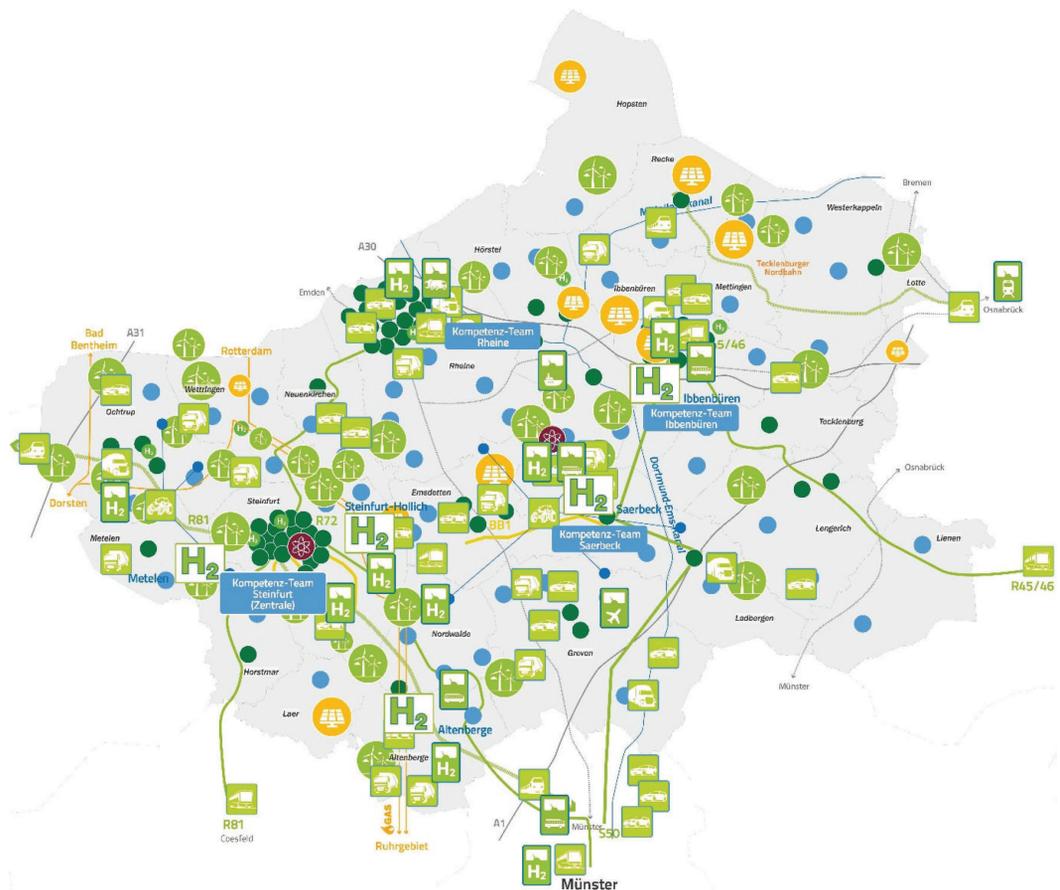


Figure 2: HYMAT hydrogen competence center in the Steinfurt district. Map of producers, users, actors and the infrastructure for hydrogen production and use (source: Steinfurt county [11], with kind permission).

participate in the citizen wind farms in the Steinfurt district [9].

The regional energy transition is supported by a broad network: the wind farm operators anchored in the region, the companies, the banks, the seven municipal utilities, the communities and, last but not least, the citizens as “prosumers” - together they want to generate themselves what they consume locally. As a result, more and more money (investments, energy expenditures, business taxes, etc.) remains locally with the trades, the investors, the municipalities, and the people. Here, the network idea of the new energy world is already fully lived. According to the head of energieland2050, Silke Wesselmann, this also includes a certain self-sufficiency mentality [10]. The goal of self-sufficiency would be “widely supported.” Here we find an important element of the new energy world: acceptance.

Of course, the district of Steinfurt is also at the forefront when it comes to hydrogen. Based on the activities of the energieland2050 association, the people of Steinfurt are working to establish the hydrogen competence center HYMAT-Energy [11]. A total of 32 measures with 130 individual measures were developed in a detailed concept. The basic approach is that the green hydrogen comes from the region's renewables and is also used there. By 2030, the aim is to have built up a corresponding hydrogen infrastructure with electrolyzers and hydrogen filling stations.

Municipal mobility

With 165,000 inhabitants, the city of Osnabrück is one of the three centers in northwestern Germany besides Münster and Oldenburg. Stadtwerke Osnabrück (municipal utility) is also responsible for operating local public transport and has repeatedly attracted attention for years with pioneering projects. They want to develop from a pure public transport operator into a complete mobility service provider for the people in the region [12].

The aim is to combine new offerings based on new forms of propulsion in a smart and sustainable way, emphasizes mobility board member Stephan Rolfes. And this in an environment of increasing flexibility, individuality and independence. Stadtwerke Osnabrück is therefore focusing on an environmental network with an electrically powered and well-developed bus network as its backbone and a multi-stage digitization strategy for the simple and intelligent use of all services [12].

In the first year, a total of 35 buses were on the road electrically and emission-free. The ultra-modern vehicles in the class “We drive electricity” MetroBus design now dominate the cityscape of Osnabrück. This system is supplemented by feeder and pick-up buses in rural and suburban areas, small shuttle buses that can be ordered via app. An expanded public transport system based on demand, consisting of scheduled and on-demand services, forms the backbone of the envi-

ronmental network. In addition, there are collaborative offerings such as car, ride and bike sharing. [12].

Smart Cities

A city's energy management will look completely different than it has in the past. There will no longer be the one utility that supplies and distributes energy. New, truly municipal solutions are required. Shared responsibility for dealing with energy will become obvious, especially in cities. Here lies a core of a new energy society.

But the real challenge of smart cities is far more than just an energy issue. In the smart cities of the future - and in some metropolises this has already begun - many areas will be interlinked. Smart buildings, digital building information management (BIM), smart transportation technology, electro mobility and charging infrastructure, intelligent administration, digital communication - the city of the future is a business model that can be mapped, simulated and analyzed digitally.

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