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Discussion Paper 1

Renewable Energies – A Chance for New Regional Industry Development? - The Case of the 'Living Lab Energy Avant-Garde Anhalt'

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Foreword:

This is a discussion paper. This is to say, it is work in progress. The work will be continued and the paper updated regularly in the future. The aim of this paper is to attract the attention of other researchers, who are working in the field of regional economic and industrial development, in order to obtain their feedback and advice for the future work.

The status of the current work is May 15th 2020 (3rd version).

Introduction:

The shift towards renewable energies is dominantly discussed in two different camps; the camp of the natural scientists on the one hand, and the camp of the politicians on the other. The natural scientists mainly concentrate on collecting data with respect to global warming and its effect on sea levels, expansions of deserts, varieties of flora and fauna etc., with the intention in mind to provide reliable, scientific information and evidence to the persons responsible for formulating environmental policies. The debate amongst the natural scientists is very specialized, focused and, given the undisputable evidence of the proceeding climate change, not controversial.

In the political camp the focus is more or less on the implementation of national or international agreements. That means that topics like environmental policies in general, discussions about global warming, international agreements like the

Paris accord, or the effects of CO2 emission reduction (or the lack of it) on the global climate dominate the agenda. In most countries of the European Union and particular in Germany, there is a very broad consensus about the necessity to implement measures to reduce CO2 emissions drastically and shift away from conventional fossil to renewable energies. In Germany, but also in other EU countries, there is also a broad public and political consensus to discontinue nuclear energy generation.

The focus of the political debate is, as outlined above, very narrowly on environmental and energy related issues. Lesser attention, however, is paid to economic aspects of the shift towards renewable energies, which means the fundamental restructuring of energy production, supply and consumption. This is not to say that economic issues are entirely ignored or considered to be of only minor importance, but often the arguments are merely assumptions in the sense that countries and companies that are leading the way towards green technologies will enjoy a competitive advantage in the future.

Almost entirely neglected in the discussion so far is, whether the shift towards renewable energies could be an opportunity for strengthening or even reviving local and regional industries. Given the fact that the shift towards renewable energies necessarily has to go hand in hand with the decentralization of energy production (the generation of renewable energies demand much more space than fossil or nuclear energy generation) the opportunities, which the shift to renewable energies could offer for regional economic and industrial development, is obvious.

This is the topic of this working paper.

It is intended to be a case study of the Living Lab Energy Avant-Garde Anhalt (*Energieavantgarde Anhalt*) in Saxony-Anhalt, Germany. The Living Lab was established in 2015 as an experimental area to explore what challenges and problems on the one hand, but especially also what chances and opportunities the German energy turnaround (shift to renewable energies) could bring at the regional level. The region Anhalt is in particular interesting, because the region was characterized by extensive lignite coal production until German reunification in 1990. After 1990, the region like so many in the former Eastern part of Germany suffered massive industrial decline. In Saxony-Anhalt not just in the energy sector,

but also the second dominant industry sector, the chemical industry, shrank considerably, which resulted in a massive out-ward migration of especially young and well educated workers. This means that the Living Lab Energy Avant-Garde Anhalt is located in an area that suffered considerable structural change over the last three decades, and it is therefore tremendously interesting to see, whether the Living Lab and the shift to renewable energies could turn the page and make the region again attractive for new industrial developments.

The paper will in the first part outline the German energy policy, in particular the decisions to abandon nuclear energy generation in first step until 2021, and to phase-out and end lignite and hard coal energy generation in a second step until the mid 2030s.

The second part will introduce the concept and the peculiarities of Living Labs, which increasingly gained importance in testing the ground for fundamental technological and social changes.

The third part will outline the already proceeding shift away from conventional energy generation to renewable energies, in particular with respect to its effect on employment.

The fourth part will give a broad overview over the region Anhalt and its industrial and economic structure. This will be followed by a more detailed introduction of the Living Lab Energy Avant-garde Anhalt.

The paper will finish not with a summary, but rather with an account of the research work that lies ahead in the coming weeks and months.

The German Energy Turn-around *(Energiewende)*: Abandoning Fossil and Nuclear Energy Resources

The German Energy Turn-around is based on two pillars. The first pillar is the shutdown of all nuclear power plants until 2021. The second is the abandoning of most of Germany's fossil, in particular coal fueled power plants until around 2035.

With respect to nuclear energy, first organized movements against the use of nuclear technologies started in Germany already in the early 1970s. Safety concerns on the one hand, and in particular concerns that Germany might use the technology for becoming a nuclear military power were the main motives for

the movement, which led to the foundation of the German Green Party on January 13th 1980 (Bündnis 90/Die Grünen; 2019; p.6). Local and regional civil support in resistance to particular two major projects, the nuclear reprocessing plant in Wackersdorf, Bavaria, and the “interim” nuclear waste storage site in Gorleben, Lower Saxony, strengthened the anti-nuclear movement in the early to mid 1980s (ibid; p.24-27). After the nuclear accident of the Chernobyl nuclear power plant in Pripyat in the Ukrainian SSR of the Soviet Union, also the German Unions and the Social Democratic Party (SPD) gradually adopted the anti-nuclear position. In 2002 the coalition government of Social Democratic Party and Green Party under Chancellor Gerhard Schröder passed the Nuclear Power Phase-out Law, which did not define an exact final date of shutting down Germany’s nuclear power plants. Giving in to the pressure of the energy supply companies, the coalition government of Christian Democrats (CDU/CSU) and Liberal Democrats (FDP) headed by Angela Merkel (second cabinet Merkel) in October 2010 passed legislation to extent the operation license for the nuclear power plants between eight and 14 years depending on the date of their first commissioning. However, under the immediate impression of the nuclear disaster of Fukushima, the government on the 14th of March 2011 initiated the U-turn of its energy policy and until the 6th of June prepared a new Nuclear Power Phase-out Law, which came into effect with the decision of the German Bundestag (parliament) on the 30th of June 2011. Based on this legislation, the last three German nuclear power plants will be shut down in 2021. This time the phase-out seems to be irreversible, since nuclear energy simply has no social acceptance in German society any more.

Regarding the Phase-out of fossil energy (lignite and hard coal) generation, at the time of writing (March 2020), the necessary legislation is still in the preparation stage. However, since energy production, buildings and transport, which are mainly fossil energy based, account for more than 80% of Germany’s greenhouse emissions, a fast and continuous phase-out of energy generation from fossil sources, particular lignite, is inevitable for Germany reaching its CO2 emission targets. In accordance with the Paris Climate Accord and the EU, Germany has set its targets to reduce CO2 emissions by 40% until 2020, 55% until 2030, 70% until 2040 and by 80% to 95% until 2050 (BMWi, 2019a, pp. 15-16).

For preparing the phase-out of coal energy generation, the German government set up the Commission on Growth, Structural Change and Employment, which is usually just referred to as 'Coal Commission' on June 6th 2018. The commission delivered its final advisory report on the 26th of January 2019. Based on the report of the 'Coal Commission' the German government has drafted a bill, which is currently subject of parliamentarian discussion. The bill sets separate targets for the reduction of electricity generation of lignite power plants and hard coal power plants. Until 2022, electricity generation from both, lignite and hard coal, should be reduced to 15 Gigawatts each, until 2030 to 8 Gigawatts for hard coal power plants and 9 Gigawatts for lignite power plants, and finally at latest until 2038 to zero for both types of power plants (BMWi, 2020a, pp. 14).

Of course, the reduction of electricity generation from coal power plants has to be compensated by a tremendous increase of renewable energies' generation. However, since energy generation from renewable sources is subject to considerably higher volatility and thus entails a far higher degree of uncertainty in terms of supply security, living labs are indispensable in preparation of the energy turn-around. Living labs provide the opportunity to implement measures under actual everyday conditions applying a trial-and-error approach in order to figure out what is feasible and where the problems are, when shifting energy supply from fossil to renewable sources. The concept of the Living Labs will be outlined below.

Living Labs: Concept, Peculiarities and Prospects

Living Labs, in German *Reallabore*, swiftly evolved over the last decade in Germany as a standard tool for testing and experimenting under actual everyday conditions first and foremost in technical areas like digitalization, energy generation, and mobility, but also in less technical areas like for instance testing new concepts of how to smoothly integrate refugees from Syria and other countries into German society.

The origin of Living Labs is hard to trace back and can supposedly not be assigned to a specific country, since in many countries approaches evolved simultaneously to test the impact of innovations in order to respond adequately with appropriate new regulations. Besides Germany and other EU member states,

also the UK, Australia and Japan were amongst first countries, which realized the potential of Living labs. Maybe due to the various different approaches, there is also quite a variety of terms used to describe this experimental approach. Beside Living Labs also for instance *regulatory sandboxes* or *real world laboratories* are used frequently.

With respect to Germany, the Ministry for Economy and Energy (*Bundesministerium für Wirtschaft und Energie* – BMWi) at the end of 2016 took an organized approach to systematically establish Living Labs in order to support the government's regulatory policies in particular with respect to new technologies in the age of digitalization (BMWi, 2018, p. 1). The Coalition Agreement of March 2018 sets out an even much larger spectrum of possible applications for Living Labs in various political fields. However, digital innovation, mobility, energy, e-government etc. remain the most important fields (CDU, CSU, SPD, 2018, pp. 37-49). In order to coordinate the efforts, the German government has set up an inter-ministerial working group 'Living Labs' on November 27th 2018, as well as established a network organization with the intention in mind to foster information sharing amongst the practitioners of Living Labs, which met for the first time on August 28th 2019 (BMWi HP, Digitale Strategie).

Based on the definition of the Ministry for Economy and Energy, a Living Lab provides the testing ground for innovation and regulation. The main purpose is to test new technologies and new business models, in order to understand the chances and risks of new innovations and to react to these chances and risks with appropriate regulations.

Living Labs are private-public co-operations between entrepreneurs (firms), research institutions and regulatory bodies on different levels (national, federal, and local or municipal governments). They are (1) temporal and spatially limited areas for testing new innovations, (2) provided with room for legal maneuvers, and (3) pursue the purpose of gaining new knowledge with respect to future regulations (BMWi, 2019b, p. 7). The decisive points definitely are the provision of experimental clauses (right to override existing legal requirements) on the one hand, and its purpose, which is to acquire knowledge how to effectively regulate new technological innovations on the other.

According to a survey of the Living Lab Network initiated by the Ministry for

Economy and Energy from February 2020, two-thirds of participants in Living Labs are universities and other scientific institutions as well as companies, many of which are start-ups. When looking at the field of expertise, which to some extent reflects also the main areas of the Living Labs' undertakings, mobility (43.1%), energy (38.5%), and smart cities (33.1%) are by far the dominant areas, while logistics (14.6%), e-Health (10%), e-government (12.3%), as well as finance (10%) are less strongly represented (BMWi, 2020b, slides 2, 5 and 6).

Based on the above definition, Living Labs provide the opportunity for experimenting even in very sensible areas like energy supply. Since they are not aiming at a technical breakthrough, their task is simply to figure out where technical or regulatory boundaries are, and what can be achieved in reality.

Since Living Labs are temporary and restricted to a well-defined spatial area, they have the right to alter existing regulations, even to the extent to challenge the privileges of established actors, which is especially in the energy sector a decisive point, since the energy sector is characterized by few, very powerful oligopolies. The right to overrule existing regulations is also very important with respect to the shift to renewable energies, because this shift can only be successful, if the sectors of electric energy generation, heating and cooling of houses, and individual mobility are integrated. Since, however, the existing regulations are sector specific regulations, they do not provide the opportunity to integrate the various different sectors.

By offsetting economic disadvantages, the Living Lab can for instance support the development of *prosumer*[1] structures in the energy sector.

To summarize, the Living Lab provides the opportunity for experimenting and testing new technologies with the perspective to translate the experiences made in the "laboratory" into new social innovations and regulations.

The German "Energy-turnaround": (A) Development of Employment in the Conventional and the Renewable Energy Sector

Black coal and in particular lignite for long time were the only domestic source of energy in Germany. As a result of that Germany's energy supply, particular with

[1] Prosumer = artificial word indicating that the producer of energy is at the same time also its own customer, which means the consumer

respect to electricity generation, has for long been dependent on lignite and hard coal.

Despite the declining share of energy generation from coal and the end of domestic hard coal mining in 2018, still more than 40% of electricity is produced from hard coal and lignite.[2]

First, we will look at data with respect to the share of lignite and hard coal in Germany's gross electricity generation. This will help us to put the German Energy Turn-around into perspective and get an understanding of the challenges energy producing regions like Saxony-Anhalt are facing.

Table 1: Gross Electricity Generation in Germany 2016

	Share in Electricity Generation	Share in CO2 Emissions
Renewable Energies	29.9%	0%
Natural Gas	9.6%	13.6%
Hard Coal	18.2%	29.8%
Lignite	23.9%	50.8%
Mineral Oil	5.1%	5.8%
Nuclear Energy	14.2%	0%

Data: Bundesumweltamt and AG Energiebilanzen e.V. (see also NABU)

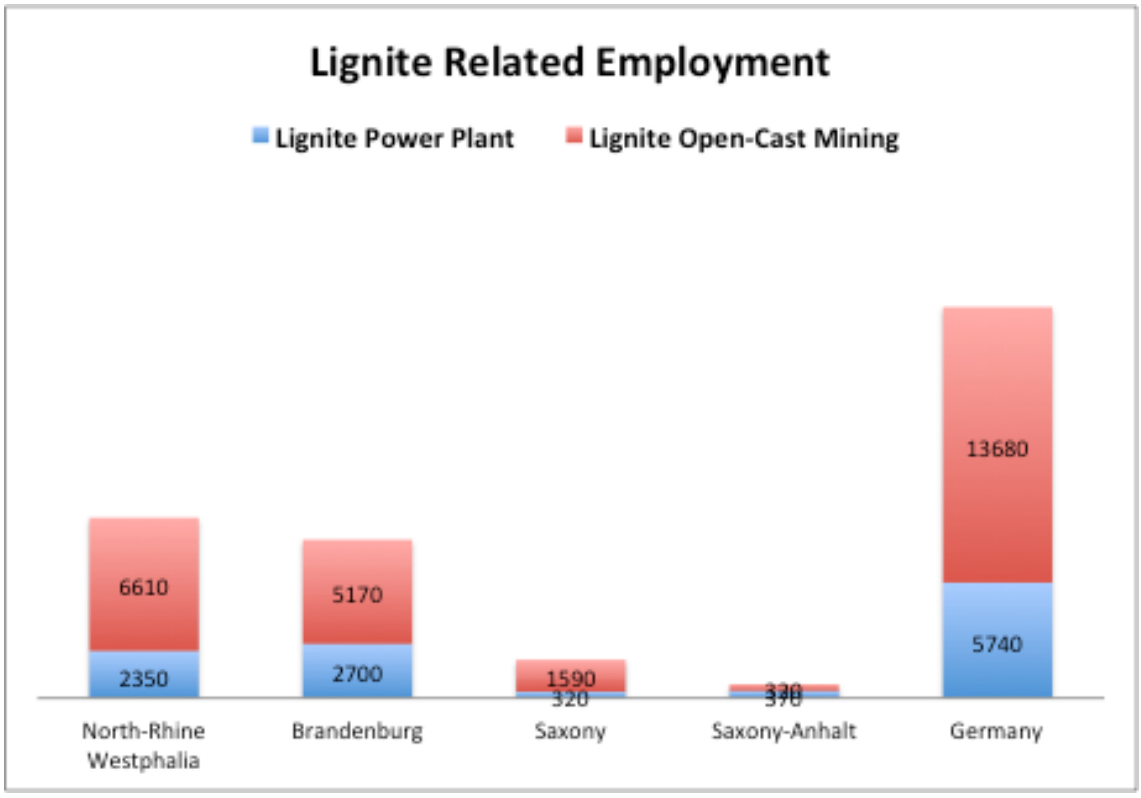
Based on CO2 emissions, lignite power plants account for more than half of total CO2 emissions, but provide not even a quarter of electric energy. Adding the emissions from hard coal power plants, coal fired electricity production contributes 42.1% of electric power, but accounts for 80.6% of CO2 emissions.

Comparing the data of contribution to supply of electric energy and the related CO2 emissions above with data for employment, we will realize that renewable energies, however, are already far more important for employment than the

[2] The last domestic hard coal mine, Prosper-Haniel in Bottrop, North Rhine-Westphalia, was shut down on the 21st of December 2018.

traditional sectors of energy production.

Graph 1: Regional Employment in the Lignite Industry

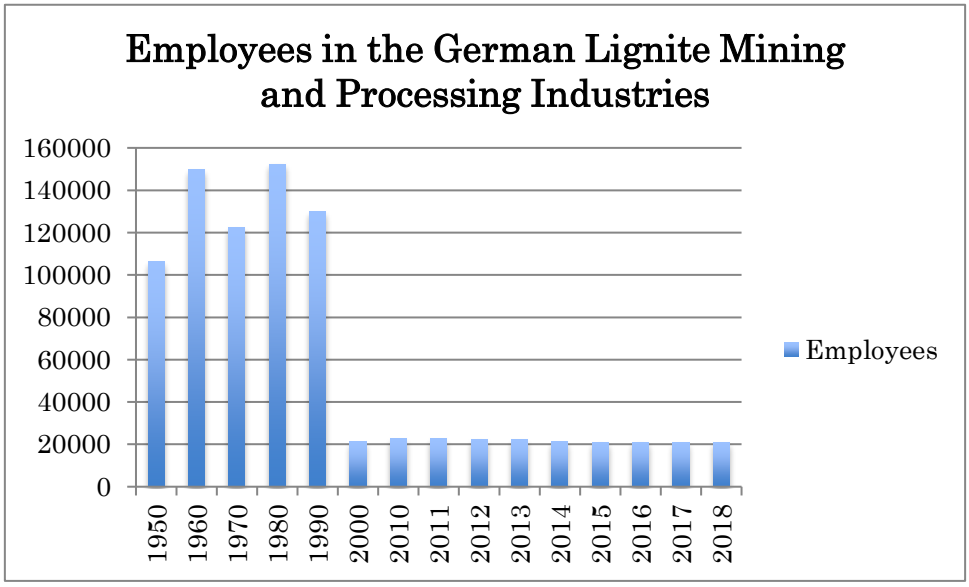


Data: Bundesumweltamt

Apart from North-Rhine Westphalia, the traditional mining area of West Germany, and Brandenburg in the East part of the country, lignite mining is not any longer a major sector for employment.

When looking at the long-term development, we see that after German unification in 1990, employment figures in the lignite mining industry severely slumped. Apart from discontinuing mining activities in areas, where lignite mining was not longer economically viable, the sharp decline in employment is also attributable to proceeding automation in mining and processing of lignite.

Graph 2: Development of Employment in the German Lignite Industry since 1950



Data: Statista (Lignite)

This sharp decline of employment in the lignite industry is in stark contrast to the continuous increase in employment in the renewable energy sector. Already in 2016 with 338600 people employed in the renewable energy sector, total sector employment by far exceeded the number of people working in the coal mining and processing industries. Broken down into the respective areas of renewable energy generation, employment related to wind energy and bio-energy (bio fuels) is particular high.

Table 2: Employment in the Renewable Energy Sector

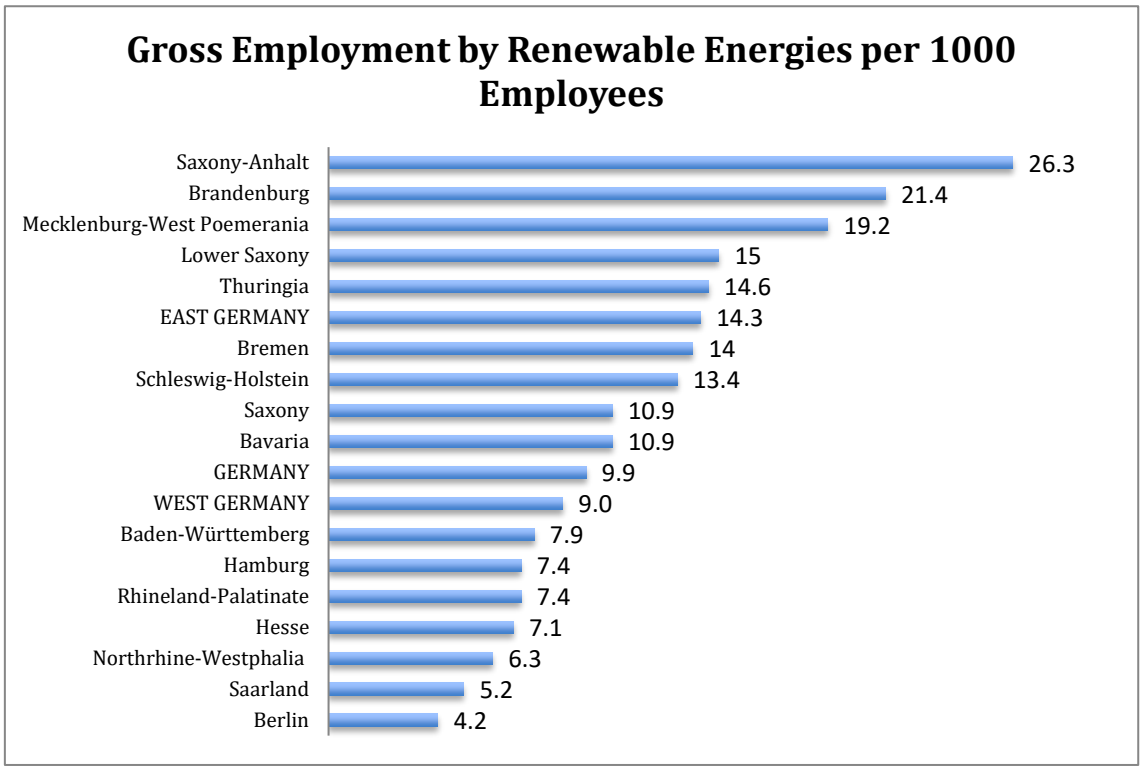
	Employees	Percentage of Total Sector Employment
Waterpower	7300	2%
Bio-energy	105600	31%
Solar energy	45200	14%
Wind energy	160200	47%
Geothermic	20300	6%

Data: Agentur für erneuerbare Energien

Since the data above record only direct employment, overall employment related to the generation of renewable energies is even much higher. Taking value creation along the whole value chain with related services into account, employment in the renewable energy sector in German might be equal to or even exceed employment in the automobile industry.

When looking at regional employment in the renewable energy sector, we see that in particular in former East Germany employment related to renewable energies is considerably higher than in almost all federal states of former West Germany.

Graph 3: Employment in the Renewable Energy Sector in the Federal States of Germany



Data: Agentur für erneuerbare Energien

There might be several reasons why employment in renewable energies is especially high in East Germany. One reason for sure is that due to industrial restructuring after German unification many old industries disappeared. A second

reason is that population density is considerably lower in the Eastern part of Germany, thus providing sufficient space necessary for the production of renewable energy. And finally, related to population density on the one hand, and to the socialization of agriculture during communism, the size of farms in East Germany is on average much larger than in the Western part of the republic, thus providing farmers with the opportunity to use their estates much more efficiently for producing renewable energies.

The German "Energy-turnaround": (B) Driving Forces and Sector Integration

The driving forces behind the German Energy Turn-around and the shift to renewable energies definitely are:

1. The fast increasing cost-performance of photovoltaic and wind energy generation equipment that make energy generated by solar panels and wind generators more and more cost competitive with traditional fossil fuel generated energies.[3]
2. The fast proceeding digitalization, which enables the exact distribution of energy between the individual energy producer and the individual energy consumer.

These two driving forces, the increase of price competitiveness of renewable energies, which result from a rapid expansion of renewable energy production locations and higher energy generation efficiency due to enhanced technologies, on the one hand, and digitalization on the other are also decisive for tackling the two major issues of renewable energies. First, the issue of volatility or stable energy supply, since the higher the share of renewable energies, the more vulnerable energy supply becomes to volatility of energy generation.

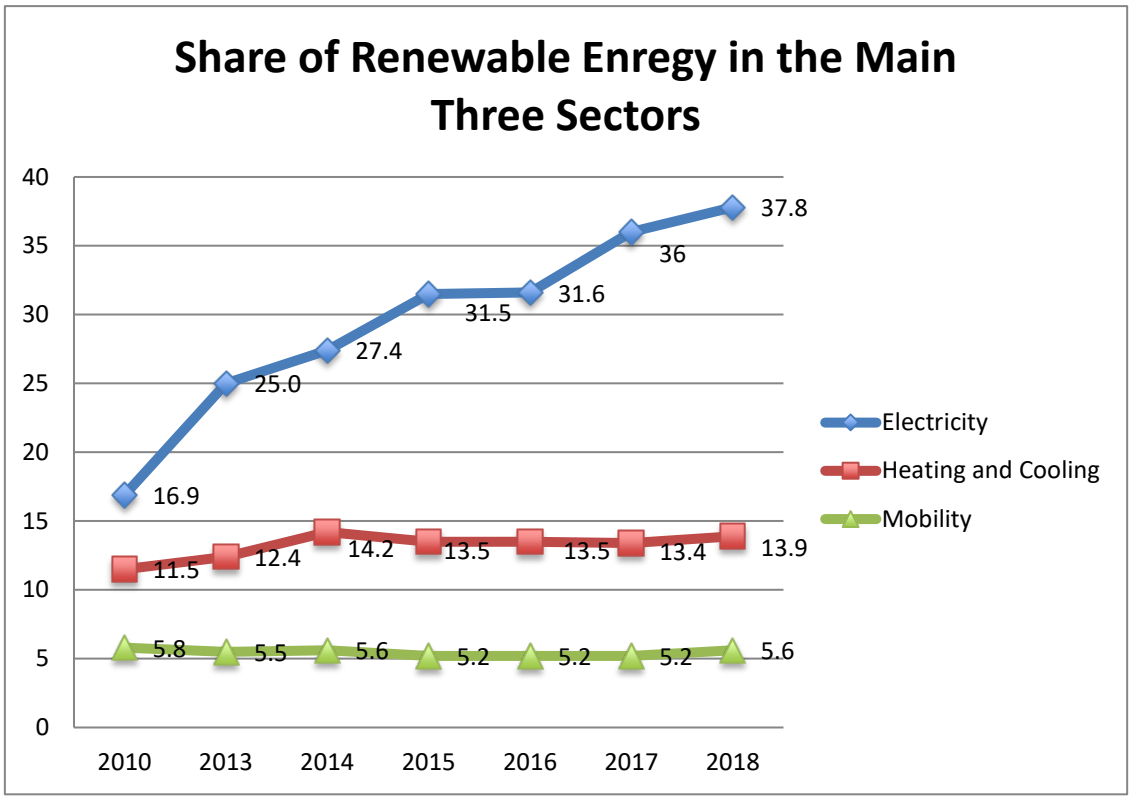
The second issue, related also to the task of securing stable energy supply, is the integration of the three most important energy sectors, electricity, heating and cooling as well as mobility.

As can be seen from the graph below, while with respect to electricity, already close to 40% is generated by renewable sources, the share of renewable

[3] The learning curve with respect to the performance increase of wind generators and PV panels is very closely following the pattern of the development of computer technology.

energies related to heating and cooling and in particular related to mobility is far lower.

Graph 4: Share of Renewable Energies in Different Sectors



Data: Umweltbundesamt

The most decisive factor for achieving the energy turnaround definitely is sector integration. For achieving this, there will be new regulations and a new market design needed in order to substitute the old energy regime with a new one. With this respect, two points will be important. First, the restructuring of energy generation from a centralized system, where one large producer delivers energy of long distances, to a decentralized system characterized by many participants (producers, consumers and prosumers) producing and consuming energy regionally (regional value creation).

The Living Lab Energy Avant-Garde Anhalt was set up exactly for the purpose to figure out how a regional energy system can be established, where the problems or even limitations are, but also where new opportunities might arise, which were so far maybe not even considered.

The Region of Sachsen-Anhalt: A Center of Innovation in the Middle of Germany:

Due to the division of Germany after 1945, many lost sight of the Eastern part of Germany and with that also of the tremendous cultural heritage of the five federal states of the GDR (German Democratic Republic). Traditionally these federal states were located right in the center of Germany – in *Mitteldeutschland* (middle Germany). This term is still commonly used for geographical descriptions, for instance the middle German lignite mining region.

Historically the region was also one center of German cultural life and innovation. In 1517 the Reformation, initiated by Martin Luther, spread from Wittenberg in Saxony-Anhalt across the world. Roughly two centuries later Johann Sebastian Bach revolutionized music in Leipzig. And with Goethe, Schiller, Herder and Wieland, Weimar at the end of the 18th century was the intellectual center of Germany. Also for this reason, Weimar became the capital of Germany after the First World War.

But not only culture, but also with respect to technology, architecture, art and design the region was in many ways a forerunner, particularly in the 20th century. In 1915, the lignite electricity power plant Zschornewitz was one of the largest in the world delivering electricity mainly to the capital Berlin. Also in 1915, the Junkers Aircraft and Motor Works built the first all metal aircraft J 1 and after the first world war in 1919 with the F 13 the first aircraft for civil aviation (Lorenz, HP). In the very same year 1919, the architecture, art, and design school Bauhaus was established in Weimar combining crafts with art. Although Bauhaus was closed in 1933 by the Nazis, the architecture, design and art of its founding members has never lost its appeal and inspired many generations of young artists and designers ever since.

So, the ‘Living Lab Energy Avant-Garde Anhalt’ is located in an area that was amongst the most innovative in Germany. Above all, the region has also a long industrial tradition as will be outlined below.

The ‘Living Lab Energy Avant-Garde Anhalt’: (A) Industry, Economy and Regional Development

The ‘Living Lab Energy Avant-Garde Anhalt’ is located in the traditional Middle German lignite (brown coal) mining area of Saxony, Thuringia and Saxony-Anhalt. As a matter of fact lignite mining in the region dates back more than 160 years. However, large-scale industrial mining only started after 1919. After the First World War, the German Empire had in accordance with the regulations of the Treaty of Versailles to concede to territorial cessions of Alsace-Lorraine in the West, which had to be handed over to France, and Western Prussia and Posen in the East, which went to Poland. With that Germany lost two of its most important coal supply regions and had to look for alternative energy supplies, although the lignite produced in Middle Germany was of far lower quality.

Already at the end of the 19th century, companies of the chemical industry like Agfa set up operations in the region. With the expansion of lignite production and strategic investments of the chemical industry during the interwar period, the region developed into one major industrial sites of Germany (Derlien et.al., 1999, p.2).

After the Second World War and the division of Germany the chemical industry located in Bitterfeld, Leuna and Schkopau contributed about 50% of the whole chemical industry and 10% of all industrial output to the GDP of East Germany (Derlien et.al., 1999, introduction).

Regarding lignite production, surface mining led to vast devastation of the natural landscape in the region and about 51000 people were relocated in order to expand production.

After German reunification, however, surface mining in the region became unprofitable and most of the production sites were shut down. With that land restoration became one the most urgent tasks in the abandoned surface mining areas.

The inevitable structural adjustments of the East German industries led to an overall economic decline, which made many especially young and skilled people leaving the region in search of job opportunities in former West Germany.

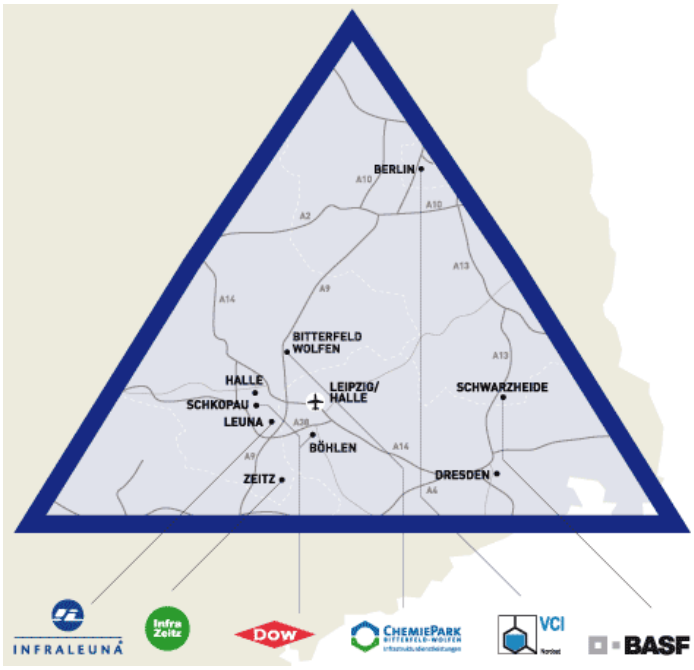
As a result of these structural changes after German unification, unemployment rate in the region still today remains considerably higher than the average unemployment rate in Germany. In particular structural unemployment (long-term unemployment, female unemployment and unemployment of workers over 50

years of age) remain high.

Despite the industrial restructuring after German unification, the chemical industry, particular in the Middle German chemical triangle of Halle (Saale), Merseburg, and Bitterfeld, still remains to be the most important industrial sector in the region, particular with respect to employment. Roughly 800 companies in the chemical, pharmaceutical, rubber and plastic industries in former East Germany employ roughly 80000 people (ISW, 2011, p. 12). Just at the largest production location of the chemical industry in Saxony-Anhalt (Leuna, Bitterfeld-Wolfen, Schkopau, and Zeitz), Saxony (Böhlen) as well as Brandenburg (Schwarzheide) about 28000 people are employed, 23000 of them in Saxony-Anhalt alone (ibid, p. 6 and p. 11).

With the highest share in Germany, the chemical and pharmaceutical industry of Saxony-Anhalt provides 13% of all industrial employment, almost double as much than the average in Germany (Heller, Julia et al., 2014, p. 23). The chemical industry is also the most dynamically growing industry in an overall, however, relatively structural underdeveloped region (ibid; p. 25).

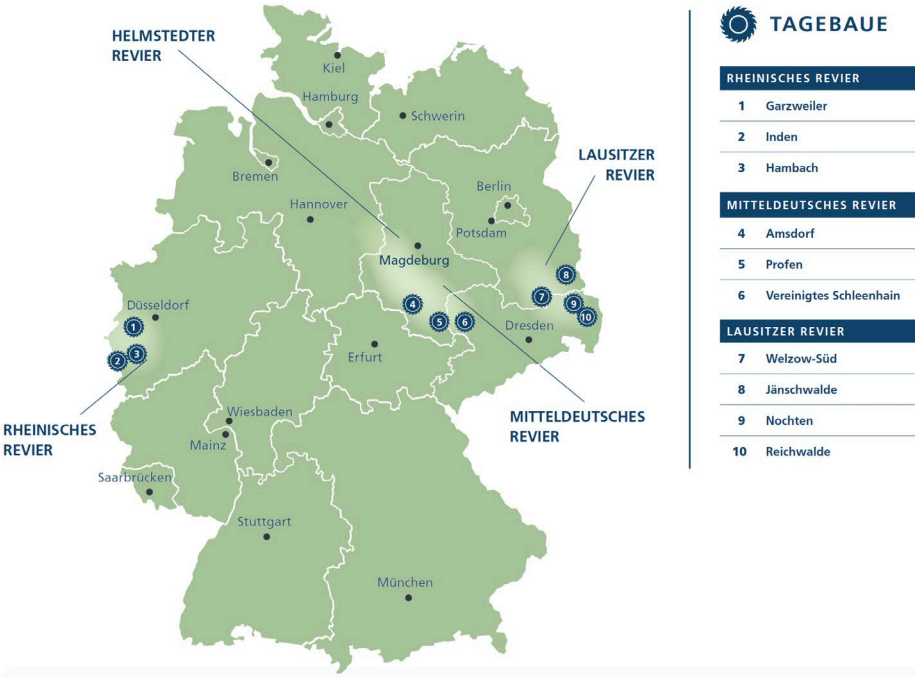
Illustration 1: The Middle German Chemical Triangle



Source: Verband der Chemischen Industrie e.V. Landesverband Nord

The situation in Middle German lignite mining and processing industries is, however, very different from the one of the chemical industry. (See illustration below, sites No. 4, 5 and 6).

Illustration 2: The German Lignite Mining Sites



Source: DEBRIV Bundesverband Braunkohle

According to a recent study of the IAB, after German unification direct employment in the Middle German lignite mining industry collapsed from about 60000 to roughly 3000 people. Until 2000 the reduction in employment went hand in hand with a stark reduction in lignite production. After 2000, however, employment again declined by about 600 people (one-fifth) despite the fact that production volume remained unchanged. Overall in 2018 about 3600 people are directly employed in lignite mining and processing industries, while another 2100 to 3600 people are indirectly employed. Between 2007 and 2018, development of employment related to lignite production and processing on the one hand, and employment in other industries on the other hand, developed further in two different directions. While employment related to lignite production and processing declined in the close vicinity of the lignite surface mines by 17.6% and in the traditional mining region at large (German: *Revier*) by 15.2%, employment

in other industries increased by 13.8% directly in the vicinity of the mines, and by 19.6% in the whole area of the *Revier* (IAB, 2019, p. 8). With this respect, however, the IAB study especially points to the importance of the lignite mining and processing (electricity generation) industries with regard to energy intensive industries in the region that are in particular located in the near vicinity of the mining areas and the power plants.[4] In the whole Middle German Lignite Mining Area 3.5% of all employees, that means 27400 people, are employed in energy intensive industries, which is also the average for Germany as a whole. However, 23% of these employees in energy intensive industries, mainly the chemical, pharmaceutical, food processing and construction material industries, are working in factories located within or very close to the mining areas (ibid, p. 14). Referring to the IAB study, the Federal Employment Agency in a press release therefore warns, that the energy-turnaround and the phase-out of lignite mining has to be implemented in way that employment in the energy intensive industries are not endangered, since many companies operate even own electricity generation facilities on site or get their electricity or process steam directly from the nearby power plants (*Bundesagentur für Arbeit* BA, press release 14.02.2019).

The above-described economical, industrial, ecological and social conditions provide the background of the Living Lab Energy Avant-Garde Anhalt and the challenges it faces in figuring out how the region Anhalt, which has been so depended on fossil energies, can shift its energy supply to renewable energies. Therefore the task is not just the shift to renewable energies, but to secure employment in existing industries other than energy, to tackle the environmental problems that resulted from lignite surface mining, enhance the attractiveness of the region for investments as well as for people to live in the region, as well as to foster tourism in Saxony-Anhalt.

The ‘Living Lab Energy Avant-Garde Anhalt’: (B) Concept and Challenges

The Living Lab Energy Avant-Garde Anhalt was set up in 2015 as one of the earliest Living Labs. The legal form of the Living Lab is a registered association.

[4] Energy intensive industries are defined as industries, where energy costs exceed at least 3 percent of production costs.

Under the title *“Join us shaping the energy turnaround at the regional level - decentralized, integrated and in cooperation,”* the mission statement of the Living Lab names clearly the actors of the association and their overarching objective:

> *“The registered association Living Lab Energy Avant-Garde Anhalt is a network of actors in the Anhalt-Bitterfeld-Wittenberg region that works in cooperation with national and European partners on the sustainable transformation of the local energy system. This association of committed citizens, municipalities and counties, companies and institutions as well as regional and supra-regional institutions wants energy to be produced and consumed in the region in an environmentally friendly way. Long power lines are unnecessary when the electricity, heat and mobility sectors are integrated. Thus, the environment and climate will be protected, and unnecessary costs for the consumer avoided.”*

Citation from: Energieavantgarde Anhalt HP (English translation by the author)

However, clearly the objectives are defined, the energy turnaround on a regional level is challenging. Challenging because huge technical, economic and social changes are needed to succeed. Challenging also, because of course on a regional level the financial budget is as limited as the sphere of influence of the political actors is.

However, the Living Lab from the very beginning was firmly focusing its efforts and actions on the regional level, since the energy sector is not just a technically, economically, and regulatory complex issue, but there are also cultural, social and regional peculiarities to be considered. These regional peculiarities, in particular the long tradition of energy generation and of producing a large variety of chemical products over decades in Middle Germany, however, can also be a tremendous advantage. As various studies have shown, technical expertise and knowledge remain in regions with a long industrial tradition, even over several generations.

The regional approach was chosen deliberately, since it was to same degree also dictated by the specific requirements of renewable energy generation. Different to centralized conventional energy generation and supply systems, where there is one large provider in the center of a supra-regional network supplying energy often over long distances, renewable energy generation requires much larger spatial areas for ‘collecting’ green energy. Because of this fact, there cannot be

one large centralized producer, but there have to be many producers (collectors) of green energy, generating and distributing energy within this network of small producers. In order to secure stable energy supply, and by that avoiding the construction of new large electricity lines, the task and the real challenge is to organize and optimize this system of many small energy generators in a way that energy is exactly delivered to the second where it is required. This can only be organized and managed regionally.

Another measure for balancing the volatility, which is inherent in renewable energy generation, and also for reacting to changes in energy demand, is to integrate the different energy producing and consuming sectors (electricity, cooling and heating, as well as mobility), which is also only feasible in a regional context.

1.) Keyword: Decentralization

Therefore, decentralization of the existing, fossil fuel dependent energy system, and reorganizing energy generation and supply on the regional level has been the key challenge that has to be mastered. This task has been especially challenging because many, new small energy producers have to be integrated and interconnected in this intelligent network, in order to connect producers with small, medium and large size consumers and to deliver energy to the split second. As already pointed out, increasing the number of energy producers (and consumers or prosumers) considerably has been also an inevitable requirement in order to achieve the necessary scale and network stability.

2.) Keyword: Participation

Participation is the second keyword. Participation not just refers to energy producers, but to also to a large number of other actors and stakeholders. The purpose is to generate value creation in the region for the benefit of the region, that means the benefit of all participants. The main participating actors are (a) economic actors, (b) political actors, (c) research and development related actors, and (d) energy producers and prosumers.

In working together these actors pursue three main objectives:

1. Establishing a highly efficient regional energy system (regional benefit)
2. Realize technological and economic innovations for the region
3. Contribute to social transformation in education, culture and tourism

Illustration 3: The vision of an intelligent regional energy system:

Source: Energieavantgarde Anhalt (Translation will be added later).

These three main objectives are arranged like a pyramid.

The basis is (1) the establishment of a regional energy system, which is based on renewable energy generation, supplies energy exactly to costumer demands and operates profitably in the interest of the region and all participating stakeholder.

This intelligent regional renewable energy system should initiate (2) future technical and economic innovations in the region exceeding just the energy sector.

Finally, based on these new innovations (3) all regional actors actively contribute to transformation processes in areas like education, tourism and culture.

The ‘Living Lab Energy Avant-Garde Anhalt’: (C) Co-operations and Synergies with Other Initiatives and Projects

A detailed analysis of the economic and industrial development of the Living Lab based on empirical data cannot be presented at the moment. It will be, however, added in later versions of this paper.

At this point, however, there are three projects that are closely related to the

Living Lab that underline the importance of the Living Lab as the leading driver for change and innovation in the region.
Two of the projects are intended to actively support the regional energy turn-around, while one is focused on fostering tourism in the area of a former surface mining field that has turned into a lake landscape after mining was abandoned.

1. Computer Program - StEmp Tool (Stakeholder Empowerment Tool)

Gaining the cooperation of the Reiner Lemoine Institute, an independent non-profit organization located in Berlin, which is focusing exclusively on research of renewable energies and related areas with the objective to contribute to an energy transformation to 100% renewable energies, researchers and computer program developers of the institute developed a program that can simulate the production of renewable energies based on the technological development of the energy generators, the landscape, climate as well as existing legal regulations. With this program long-term development scenarios can be simulated and projected that are not predictions, but in fact realistically achievable objectives.
The computer application especially developed for the energy turnaround in the region Anhalt-Bitterfeld-Wittenberg is called StEmp Tool (stakeholder empowerment tool) Anhalt-Bitterfeld-Wittenberg. It can be used to simulate the production and supply of renewable energy in the region based on existing (or future) capacities according to all relevant parameters as for instance technological development of the generators, legal requirements, and local conditions like for instance average hours of sunshine or strength of wind.
This computer tool, which was specifically developed for the Living Lab Energy Avant-Garde Anhalt, enables the members and participants of the Living Lab to especially base their arguments for the further extension and development of the Living Lab with respect to governmental or EU institutions on a reliable basis and especially enables them to fight of the arguments of yesterday people, who fight for the continuation of the fossil energy economy, not having realized that the future is sustainable, renewable energy production and consumption.[5]

[5] Information: Presentation of the first introduction of StEmp Tool given in Dessau by representatives of the Reiner Lemoine Institute on March 27th 2019.

2. Ferropolis – City of Iron

Ferropolis is in the first place an industrial museum as well as an event area, located on the peninsula in the Gremminer lake, which resulted after abandoning the surface lignite mining in Golpa North. The Buildings and in particular the old control room is used for a permanent exhibition about the history of lignite mining in the area. A variety of huge sized bucket-wheel excavators formerly used at the site for lignite mining are now serve as a tourist attraction and provide the scenery at the occasion of concerts and other events.

The Ferropolis site is on the one hand a renewable energy provider to the Living Lab Energy Avant-Garde Anhalt, and on the other hand also contributes to the wider objectives of the Living Lab, particular with respect to enhancing the attractiveness of the region, fostering tourism as well as a lively cultural life in the region.

The event area has a capacity for up to 25000 visitors, who can reach the site by using the old railway line, formerly used for transporting lignite coal. For this purpose also some old locomotives and train wagons were restored.

The concept for all activities is to be as ecological and CO2 neutral as possible. So besides energy consumption, and transport provided by the old mining railway, the site is exceptional in waste and water recycling including all water used for the lavatories at large events.

The close connection to the Living Lab Energy Avant-Garde Anhalt is also manifest, because the manager of the Ferropolis LLC (limited liability company) serves also as the president of the supervisory board of the Living Lab.

In this respect Ferropolis can be perceived not just as a contributor to renewable energy and the regional energy turnaround, but as an integral part of the whole intended economical, ecological, social and cultural shift in the region.[6]

3. Hydros – Hydrogen Energy Living Lab

One peculiarity of the East German chemical industry had been that the production locations were inter-connected by an extensive pipeline network. After the restructuring of many companies, a number of these pipelines were not any

[6] Information: Interview 27th March 2019 with the managing director of Ferropolis

longer used and lay idle. This provided Hypos, another Living Lab in Saxony-Anhalt, with the opportunity of re-using the old chemical and gas pipeline infrastructure for the purpose of distributing hydrogen. Since the pipeline infrastructure already existed, there were no major capital investments necessary. The hydrogen is ecologically produced at times when there is an excessive generation of wind or solar electricity. The hydrogen is mainly used for industrial purposes, but also to some minor extent for transportation, in particular for operation of trains on non-electrified railway lines. As a representative of the Living Lab explained in an interview, one objective for the future is to expand more into the transportation sector, however, at the moment the highest potential for hydrogen, besides industrial application, presumably rather lies in the field of railway transportation than in automobile mobility.[7]

Illustration 4: Hypos Logo and Hydrogen Pipeline Network:

Source: Hypos

Outlook: Future Research Tasks

This discussion paper so far is descriptive and mainly concentrates on the

[7] Information: Interview 27th March 2019 with PR representative of Hypos

establishment of the Living Lab and its objectives.

In the next research stage, empirical data has to be added in order to illustrate what effects the Living Lab has on:

1. The regional energy mix
2. On employment in the renewable energy and related sectors
3. On industry settlements in other sectors, not directly related to the energy sector (spill-over effects)

A second focus of the upcoming research has to be on outlining in detail the measures that are or were taken with respect to sector integration, particular in fostering sustainable development in the areas of heating and cooling as well as mobility. Specifically with this respect the question has to be raised, to what extent existing regulations had been altered and what the effects of these alterations were.

And finally, it has to be asked what effects the Living Lab has had on regional development as a whole, especially on the intended transformations of tourism, culture as well as education.

For answering these questions extensive empirical studies in Germany are planned.

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