

Smart strategies for the transition in coal intensive regions

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Research & Innovation strategy in the field of energy for Lusatia

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Executive summary

How is Lusatia positioned with regard to its medium- to long-term future strategy for research and development in the energy sector? To answer this question, it should be noted that Lusatia is not a separate administrative unit, but a cross-border region between the federal states of Brandenburg and Saxony.

With the *Lusatia 2050 development strategy* (Wirtschaftsregion Lausitz GmbH, 2020), a broadly coordinated future concept, that affects all relevant areas of public life, already exists since autumn 2020. Aspects of research and development in the energy sector are an integral part. Therefore, there is neither need nor a basis to develop a new regional R&I strategy within the TRACER project.

The current research landscape in the region is well positioned basically. In the core area there are the Technical University Cottbus-Senftenberg, the University of Applied sciences Zittau-Görlitz and a number of non-university research institutes, like FIB Finsterwalde, that deal more or less with energy topics and renewables.

Financing is currently provided, and will be in the foreseeable future, through institutional funding from the federal states Brandenburg and Saxony or funding programs, particularly from the German federal government.

The region's research institutions are basically well-connected research. They have many references to the topic of energy, although in Saxony many institutes and activities are concentrated in Dresden, which is not part of Lusatia, but adjacent. One challenge, however, is that young and well-educated people still too often leave the region to work and live elsewhere. The ageing of the population has already a detrimental effect on the labour market in Lusatia, not only in the area of research and development. Accordingly, an important task is to get more attractive to young people from the region and highly qualified people from outside Lusatia.

1 Introduction

1.1 Development of the Strategy: Overview of the process

In Lusatia, the *Development Strategy Lusatia 2050* (Entwicklungsstrategie Lausitz 2050, Wirtschaftsregion Lausitz GmbH, 2020) is an already existing strategy for medium- to long-term development in the region, which takes particular account of aspects of research and innovation in the energy sector. It was finalised in autumn 2020 in the *Lusatia Future Workshop (ZWL) - Development of new perspectives within the framework of cross-border regional development in Lausitz*, a project of *Wirtschaftsregion Lausitz GmbH* that began in December 2017. The strategy was developed in a participatory process in which around 2,500 people from Lusatia were able to contribute their ideas and perceptions in various participation formats.

The strategy is intended to form the coordinated framework for shaping a sustainable and liveable Lusatia and to be an important basis for structural change. The mission statement formulated in it describes Lusatia, among other things, as a CO₂-neutral economic area in which existing economic structures have been evolved in the sense of a green industry approach. By anchoring new technologies, sustainable value chains could be established in the region in the long term.

Consequently, it does not make sense to develop a separate, new strategy together with stakeholders in the region within the framework of the TRACER project. Instead, the relevant contents of the *Development Strategy Lusatia 2050* are presented here.

2 Setting the context

2.1 Regional profile and specialisation

Geographical Lusatia is a cross-border region in Germany and Poland. However, within the TRACER project only the German part is considered. The region does not represent an administrative unit. The German part is located in the area of the districts of Oberspreewald-Lausitz, Spree-Neiße, Dahme-Spreewald, Elbe-Elster and the city of Cottbus in the federal state of Brandenburg and in the districts of Bautzen and Görlitz in the federal state of Saxony. Historically, Lusatia comprises the area of the former margraviate of Upper and Lower Lusatia.

It is a predominantly rural region, mainly with smaller towns and many villages. Comparatively larger cities are Cottbus, Bautzen and Görlitz. Cottbus, Senftenberg, Görlitz and Zittau are cities with a university or a university of applied science. The landscape is mainly characterised by agricultural and forestry activities as well as the historical and current interventions from open-cast lignite mining.

Socio-economic differences exist within the region. In particular, the northern part of the Dahme-Spreewald district is in many respects influenced by the neighbouring Berlin and is actually no longer part of the Lusatia region. The structural change in the Lusatian lignite mining area doesn't effect this area much.

The districts of Oberspreewald-Lausitz, Spree-Neiße and Görlitz, as well as the city of Cottbus, are currently still sites of active opencast lignite mines and coal-fired power plants or were heavily influenced by mining in the past. LEAG, the only active mining company, provides jobs for about 7,000 people plus approx. 5,000 employees for suppliers & related business and thus contributes to economic development in the region. Dresden, the capital of Saxony, in particular influences the south of Lusatia as a multifunctional business and science location, quite independently of mining.

Data on gross domestic product (GDP) per capita and its development, as well as on the unemployment rate and its change compared to the previous year are currently available for each district (see Table 1).

Table 1: Regional economic and innovation indicators from the districts of Lusatia and the city of Cottbus (Sources: Amt für Statistik Berlin-Brandenburg, 2021; Bundesagentur für Arbeit, 2021)

District and NUTS-3 Code	GDP per capita (2019)	GDP per capita, changes (2010 – 2019)	Unemployment rate (October 2021)	Unemployment rate (October 2021), changes from previous month
Elbe-Elster, DE407	25,538	40.3	5.8	- 0.6
Dahme-Spreewald, DE406	33,576	12.1	3.6	- 0.6
Oberspreewald-Lausitz, DE40B	28,325	42.9	6.3	- 0.8
Spree-Neiße,	34,325	7.6	5.6	- 0.6

DE40G				
City Cottbus, DE402	35,833	25.5	6.9	- 0.9
Görlitz, DED2D	27,321	39.4	7.1	- 0.7
Bautzen, DED2C	28,073	40.4	5.1	- 0.2

Data on gross expenditure on research and development is currently available at federal state level but not for Lusatia as a region or the individual Lusatian districts (see Table 2).

Table 2: Gross expenditure on research and development in 2019, by federal state and sector, in millions of euros (Source: Statistisches Bundesamt, 2021)

Sector	Brandenburg	Sachsen
State and private non-profit organisations	581	1,075
Universities and universities of applied science	292	1,102
Private companies	486	1,687

Table 3 shows the number of patent applications per million inhabitants in the districts of Lusatia in 2012. More current figures are not available.

Table 3: Patent applications per million inhabitants at the European Patent Office by priority year and NUTS-3 regions, in 2012 (Source: Eurostat, 2021a)

District and NUTS-3 Code	Patent applications per million inhabitants
Elbe-Elster, DE407	59,660
Dahme-Spreewald, DE406	123,92
Oberspreewald-Lausitz, DE40B	37,826
Spreew-Neiße, DE40G	13,637
City Cottbus, DE402	64,232
Görlitz, DED2D	48,261
Bautzen, DED2C	66,380

Table 4 shows the population of the Lusatian districts and their change from 2015 to 2020. With the exception of the Dahme-Spreewald district and the city of Cottbus, all districts lost inhabitants within these five years, Spreew-Neiße the most (3.7 %).

Table 4: Number of inhabitants on 01.01.2015 and 01.01.2020 and their change from 2015 to 2020 (Source: Eurostat, 2021b)

NUTS-3 Region	2015	2020	Change (%)
City of Cottbus	99,491	99,678	0,2
Dahme-Spreewald	161,952	170,791	5,5
Elbe-Elster	104,997	101,827	-3,0
Oberspreewald-Lausitz	112,896	109,371	-3,1
Spree-Neiße	118,030	113,720	-3,7
Bautzen	306,570	299,758	-2,2
Görlitz	260,188	252,725	-2,9

Figure 1 shows the age structure of the population at the municipal level. There are different categorisations of the age categories in Brandenburg and Saxony because the underlying data (Amt für Statistik Berlin-brandenburg, 2020a & Statistisches Landesamt des Freistaates Sachsen, 2021a) specify this. A relatively high proportion of people of working age (20 to 60 years in Brandenburg, 18 to 65 years in Saxony) live in Brandenburg primarily around Cottbus and in the northern part of the Dahme-Spreewald district. In Saxony, this is not so clearly concentrated in one region. On the other hand, it is noticeable that the proportion of people aged 65 and over is highest in the south and north of the district of Görlitz. In Brandenburg, this oldest group is mainly found in the south of the Elbe-Elster district and in the east of Dahme-Spreewald away from the larger towns in the region.

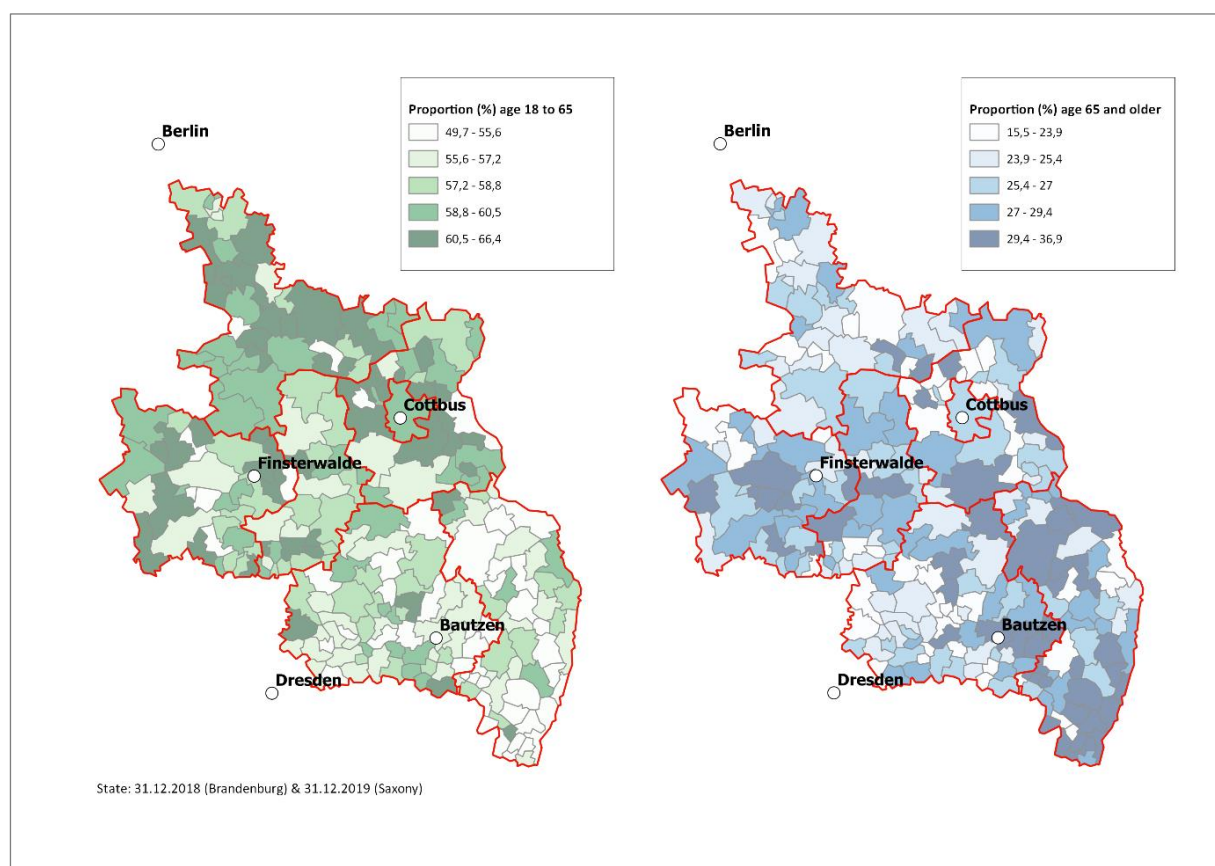


Figure 1: Age structure of the population in Lusatia (Sources: Amt für Statistik Berlin-Brandenburg, 2020a & Statistisches Landesamt des Freistaates Sachsen, 2021a)

People have left the region over the past years, but also entered it from outside - for whatever reason. Migration has an effect on the labour market for high educated people for science and innovation. Moreover, migration in Lusatia is different among the different districts and even within the districts. Table 5 therefore shows the balance of immigration and emigration from 2007 to 2017 in the districts of Lusatia. Only Dahme-Spreewald, a neighbouring district of Berlin, has a positive balance of 10.301 persons, while the others, but especially Bautzen (approx. -14.500) and Görlitz (-9.919) have lost inhabitants by emigration.

Table 5: Balance of migration in Lusatia from 2007 to 2017 (Sources: Amt für Statistik Berlin-Brandenburg, 2021b & Statistisches Landesamt des Freistaates Sachsen, 2021b & c)

District	NUTS-3 Code	Balance from 2007 to 2017
Cottbus	DE402	-4,338
Dahme-Spreewald	DE406	10,301
Elbe-Elster	DE407	-7,912
Oberspreewald-Lausitz	DE40B	-6,873
Spree-Neiße	DE40G	-7,106
Bautzen	DED2C	-14,507
Görlitz	DED2D	-9,919

As figure 5 shows for example, the migration within the districts is different. In the north of Dahme-Spreewald Berlin is located and, probably due to this, the northern part of the district shows a positive balance of migration, while the rest of municipalities have lost up to 575 inhabitants in that decade. Probably people from the south move to the north to work in Berlin and additionally people from Berlin move to the north of Dahme-Spreewald, because the property prices are lower compared to Berlin.

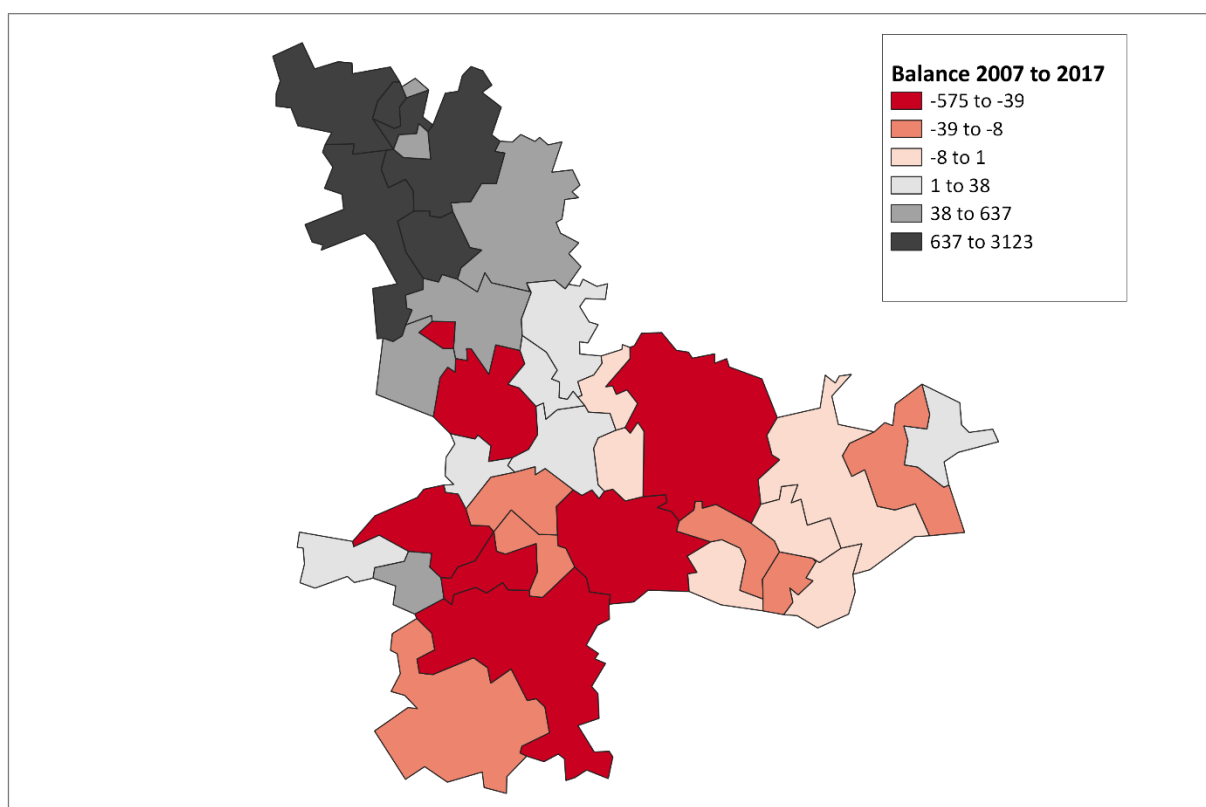


Figure 2: Balance of migration in the municipalities within the Lusatian district Dahme-Spreewald from 2007 to 2017 (Source: Amt für Statistik Berlin-Brandenburg, 2021c)

Data on the number of students in tertiary education in 2015 and 2019 are presented in Table 4 by education sector and NUTS-2 region. According to the *UNESCO International Standard Classification of Education (ISCED)* (UNESCO, 2012), tertiary education is education in the academic sector (ISCED levels 5 to 8). In Germany this includes education at universities, universities of applied sciences, vocational academies, technical academies (Bavaria) and technical colleges. ISCED level 5 refers to so-called short-cycle tertiary education programmes, in Germany the master craftsman training (BMBF, 2021). Levels 6 and 7 refer to bachelor and master degrees at colleges and universities, and level 8 to PhD students.

Table 4: Number of students in tertiary education by education sector and NUTS-2 regions, in 2015 and 2019 (Source: Eurostat, 2021c)

Sector	Brandenburg	Sachsen
Tertiary education, all	52,364 (2015)	121,868 (2015)
Bachelor or equivalent	31,859 (2019)	60,292 (2019)
Master or equivalent	20,482 (2019)	56,360 (2019)

Data on product and process innovation as well as organisational and marketing innovation are not available for the region.

2.2 energy and environment outlook

In the *Act to Reduce and End Coal-fired Power Generation and to Amend Other Laws (Coal Phase-out Act)* of 8 August 2020, two units at the Schwarze Pumpe power plant (Brandenburg, Spree-Neiße district) and one unit at the Boxberg power plant (Saxony, Görlitz district) are scheduled to operate until 31st December 2038. Together with a total of three units at the Niederaussem and Neurath power plants in North Rhine-Westphalia, they are the last units that will generate energy from lignite in Germany until that date.

However, currently it is uncertain whether this date will be kept or whether the phase-out of coal-fired power generation will take place earlier. On the 26th of September 2021 the elections for the Bundestag took place in Germany. Already before the parliamentary elections, leading representatives of all three parties have shown themselves to be generally open to an earlier phase-out of coal-fired power generation (e.g. Kreutzfeldt, 2021). And as it is fixed in the coalition agreement from 24th of November the last coal power plants should ideally (!) close already in 2030, going ahead with 80% renewable energy supply (Sozialdemokratische Partei Deutschlands, BÜNDNIS 90 / DIE GRÜNEN & Freie Demokraten, 2021).

Even after the phase-out of coal-fired power generation, Lusatia should retain its character as an energy region and industrial location (Agora Energiewende, 2017). In the *Development Strategy Lusatia 2050*, reference was made to this and corresponding goals and fields of action were formulated.

The *Berlin-Brandenburg Energy Technology Cluster of Wirtschaftsförderung Land Brandenburg GmbH (WFBB)* is also worth mentioning in this context. Since 2011, the cluster has served to network energy technology companies in the capital region with research institutions. The core topics are renewable energies, energy efficiency, energy grids and storage as well as turbomachinery and power plant technology.

In order to achieve the climate goals, the state government of Brandenburg supports the further expansion of photovoltaic systems (Ministerium für Landwirtschaft, Umwelt und Klimaschutz des Landes Brandenburg (MLUK) (2021). An area potential analysis is currently being carried out for usable areas, both open areas and sealed, but also roof and building areas. However, the preliminary recommendation for action by the MLUK indicates the use of mining areas for ground-mounted photovoltaic systems and / or Agri-photovoltaics, so that an interesting further

use for the energy generation of the mining-impaired areas is foreseeable here for the mining region Lausitia. In this context, the FIB carried out a workshop about photovoltaic systems on arable land in the post-mining landscape as a part of the future energy region Lusatia with stakeholders from Lusatia and external experts on November 17th, 2021. There were some lectures picking up the problematic aspects of photovoltaics on arable land and showing different ways of combining agriculture with energy production. Afterwards there was space for discussion to bring the different needs from the perspective of energy producers as well as farmers together. It was an exciting exchange for finding strategies to merge agricultural and energy production with the needs of recultivate the reclaimed land. The minutes are added in the attachment.

2.3 current energy related R&I landscape

Universities

Brandenburg University of Technology Cottbus-Senftenberg

The Brandenburg University of Technology Cottbus-Senftenberg (BTU) is the only university in Lusatia and, along with the University of Potsdam, one of the two universities in the Federal State of Brandenburg. Around 6,800 students study in Cottbus. At the end of 2020, there were 185 professors, 694 academic staff and 678 non-academic staff (Brandenburgische Technische Universität Cottbus-Senftenberg, 2021).

The scientific work at the BTU separates four research fields. In these research fields, scientists from various disciplines and faculties work on corresponding issues. With regard to energy, the research field of *energy efficiency and sustainability* is relevant. It involves measures to increase the efficiency of conventional power plants and make them more flexible. This includes the development of energy storage concepts, electromobility and the stability of electricity grids in the context of the energy transition.

In the context of energy, Faculty 2 (*Environment and Natural Sciences*) deals with biomass as a renewable energy source, among other things. The focus is also on raw material potentials for energy production, emission reduction through waste gas purification and new combustion processes, as well as the topics of energy consumption and energy awareness.

Faculty 3 (*Mechanical Engineering, Electrical and Energy Systems*) can also be listed here. Research here is concerned, for example, with low-emission aircraft engines and lightweight construction solutions with fibre composites. In the area of energy technology and energy systems, the challenges of the energy turnaround are considered in relation to the conversion, storage and distribution of electricity, gas and heat.

A research focus of the Saxon university, which exists since 1992, is "*Energy and Environment*" (Hochschule Zittau/Görlitz, 2021). Around 3,000 students can obtain a Bachelor or Master degree in many subjects, for example Electrical Energy Systems, Electrical Engineering, Energy and Environmental Engineering or Ecology and Environmental Protection. Central topics in the research focus are the extraction and provision of energy with regard to resource conservation, environmental protection and climate neutrality.

Extra-university research

Fraunhofer-Gesellschaft for the Promotion of Applied Research e.V. (FhG)

The section *Energy Infrastructures* of the *Fraunhofer Institute for Energy Infrastructures and Geothermal Energy* is located in Cottbus (Fraunhofer-Einrichtung für Energieinfrastrukturen und Geothermie IEG (2021). Research is conducted here on the main topics of integrating electricity, gas and heat infrastructures. This includes the development of new approaches to system analysis and modelling of sector-coupled infrastructures and the construction of test and demonstration stands for thermodynamic converters, hydrogen infrastructures and CO₂

capture and utilisation. In addition to the development of new cross-sectoral energy technologies and infrastructures, the focus is on the interaction of the various flexibility options in order to analyse and optimise their development and digitalisation requirements in an application-oriented manner, as well as to develop customer solutions and assess market potential.

DLR Institute for Low CO₂ Industrial Processes

Cottbus as well as Zittau and Görlitz are the locations of the *Institute for Low CO₂ Industrial Processes of the German Aerospace Center (DLR)* (Deutsches Zentrum für Luft- und Raumfahrt e. V. (DLR), Institut für CO₂-arme Industrieprozesse, no date). The institute's work considers the specific requirements and research needs for decarbonising large energy-intensive industrial sectors (power plants, steel production, cement industry, petrochemical industry, chemical industry, aluminium production). Furthermore, the Institute's research topics complement the activities on sustainable power generation and storage. An approach to converting coal-fired power plants into storage power plants serves the goal of further utilising existing investments and preserving jobs in Lusatia.

The institute works closely with the Brandenburg University of Technology Cottbus-Senftenberg, among others.

DLR Institute for Electrified Aerospace Propulsion Systems

The *DLR (German Aerospace Center) Institute for Electrified Aircraft Propulsion Systems* exists in Cottbus since June 2020 (Deutsches Zentrum für Luft- und Raumfahrt e. V. (DLR), Institut für Elektrifizierte Luftfahrtantriebe, no date). The institute is intended to serve research into lower-emission aircraft engines, generally more electrified future aviation engines for civil transport aircraft. The optimisation of engines and their development processes is a central research topic. The main focus is on the field of electric and hybrid-electric flight systems.

The institute will cooperate closely with the Brandenburg University of Technology Cottbus-Senftenberg and with Rolls-Royce Germany, among others.

Research Institute for Post-Mining Landscapes e.V. (FIB)

At the FIB in Finsterwalde, scientists from various disciplines work on landscape and ecosystem-related issues on a project-oriented basis. A connection to energy research results from projects in the context of bioenergy, such as the cultivation of sorghum on recultivation sites for the production of biogas or the Bioplat-EU project to promote the market acceptance of energy crop cultivation on marginal, underutilised or contaminated land. The FIB has existed since 1992, but can look back on a 60-year tradition in reclamation research at all.

Centre for Energy Technology Brandenburg e.V. und Technology Brandenburg GmbH

Centre for Energy

Both institutions are based in Cottbus. Bringing together science and business, networking activities in business networks, technology transfer and public relations are the self-imposed tasks of CEBRra e.V. (CEBra - Centrum für Energietechnologie Brandenburg e.V. & CEBra - Centrum für Energietechnologie Brandenburg GmbH, 2019). CEBra GmbH, on the other hand, offers industrial research, consulting, project management and further education as services. Both the association and the GmbH have been involved in numerous energy-related projects in recent years. A current project of CEBRA e.V. is the cross-border project *Energy Storage of the Future in the Spree-Neisse-Bober region*, which is funded within the framework of Interreg VA.

SWOT-Analysis

A SWOT-Analysis was conducted on aspects of research and development in energy technologies in Lusatia. The strengths of the region are the overall presence of several research institutions with good a networking. The main weakness is the potential shortage of high educated labours due to emigration of young people. Additionally, a few tasks have been developed, which can adress the weaknesses potentially.

Table 5: SWOT-Analysis on aspects of research and development in energy technologies in Lusatia

Strengths of the region
• Presence of a university and a university of applied sciences (BTU CS, Zittau-Görlitz University of Applied Sciences). • There are several non-university research institutions, especially in the Brandenburg part of Lusatia. • Existing research institutions deal with topics in the field of energy and environment • Good links between the research institutions and commercial enterprises • Good networking between the research institutions
Weaknesses of the region
• Age distribution of the population with a predominant share of older people who have already retired or will soon retire from working life • Continuing emigration of young and well-educated young people • In Saxony, research institutions are concentrated primarily in the large cities Dresden, Leipzig and Chemnitz (locations of universities and other institutions); in the Saxon part of Lusatia there is only one university of applied sciences, the Zittau-Görlitz University of Applied Sciences, and only one non-university institution, the DLR Institute for Low CO₂ Industrial Processes.
Chances
• Existing research structures are suitable for developing sustainable solutions in the field of energy and the environment in the long term. • The region manages to become more attractive, so that a well-trained workforce is available in the long term due to a decrease in migration and immigration.
Risks
• Existing research structures are unsuitable in the long term for developing sustainable solutions in the field of energy and the environment, because research priorities could change. • There is a shortage of qualified workers in science due to a further emigration of young people and the relatively high proportion of people who retire from working life due to their age. • It is not possible to compensate for the emigration of well-educated people with a corresponding immigration to the region.
Tasks
• Maintaining and strengthening existing research institutions • Establishment of further research institutions • Maintaining, strengthening and enhancing of existing networking structures

- Generally increasing the attractiveness of the region for people with an interest in research and science, encompassing many aspects (e.g. job offers, wages and salaries, housing/real estate offers and prices, openness to new/unfamiliar things)

3 R&I in Energy and Environment: Vision for 2030 & 2050

3.1 Objectives and outcomes

As mentioned above the *Development Strategy Lusatia 2050* (Wirtschaftsregion Lausitz GmbH, 2020) was completed in autumn 2020. The strategy intends to provide a coordinated framework for shaping a sustainable and liveable Lusatia and to be an important basis for structural change. There are manifold references to R&I, especially in the fields of energy and environment.

Table 6: Goals and approaches to action in various future fields and action categories of the *Development Strategy Lusatia 2050*

Future field: Infrastructure and services of general interest Action category: Surface mining areas, infrastructure and buildings of the energy industry
Goal: The research and use of renewable energy sources as well as the development of long-term sustainable business fields in the generation, storage and transmission of energy contribute significantly to the success of the energy transition. Fields of action: • Use of the extra-high voltage grid with interconnectors within Germany and to Eastern and Northern Europe, which originates in Lusatia and is knotted here. • Development of a reference power plant as a guiding concept for the transformation of the lignite-based energy industry. • Promotion of research and development, science and innovation in the field of energy production. • Introduce experimental clauses, "real laboratories" and regulatory measures for the use of renewable energies and climate-neutral energy production. • Develop the BTU Cottbus-Senftenberg into an energy innovation centre and integrate the Zittau/Görlitz University of Applied Sciences with its energy technology focus and STEM courses into the transformation processes. • Involve local citizens and businesses in the projects. • Test and, if necessary, use forms of renewable energy generation, e.g. hydrogen, power-to-X, floating solar modules, wind turbines and solar parks on open-cast mine tips, seawater heat pumps in open-cast lakes. • Develop reference projects, e.g. water and energy campus and floating photovoltaic system for CO₂-free supply of the harbour quarter and the lakeside suburb

Goal: The operation of facilities for the generation of renewable energies is secured in the long term by keeping areas free and permitting them under planning law.

Fields of action:

- Balancing the interests of the energy industry, tourism and nature conservation at the regional and municipal level in the official enforcement process

Future field: Innovation, research and science

Action category: Research, experimental fields and energy

Goal: The share of the following future technologies in the region has increased through innovations: Big Data, Artificial Intelligence, digitalisation, climate-friendly drives, autonomous driving, alternative mobility concepts, recultivation, circular economy, decarbonised energy production and energy storage systems.

Fields of action: Focus on these future technologies in future measures

Goal: There is more research and development in Lusatia.

Fields of action:

- Expand existing universities and study academies
- Expand research capacities (e.g. Fraunhofer, Leibniz, Helmholtz or DLR institutes; major DFG, EU or BMBF research projects; centres of excellence and innovation campuses, especially in the areas of energy-intensive industries, electronics and microsensor technology, and AI software and hardware)

Goal: The energy supply remains competitive.

Fields of action:

- Coordinate Saxony's and Brandenburg's energy strategies in order to reform the sector.
- Strategically align the hydrogen economy through cooperation between Saxony, Brandenburg and Saxony-Anhalt
- Arrange new business opportunities and markets
- Increase acceptance of CO₂-neutral energy production
- Participation of communities and the local population in economic returns
- Citizen-oriented business models (local ownership, cooperatives, etc.)
- Strengthening and expanding cooperation between business and research institutions
- Establish a centre of excellence for the sustainable generation and use of electricity surpluses (Power-to-X)

Goal: There is security of supply in the energy sector.

Fields of action:

- Accelerate the national and cross-border expansion of the supply networks for gas and electric energy
- Establish a nationwide hydrogen filling station network
- Consistent linking of the heating, cooling and propulsion sectors as a substitute for fossil energy sources

Promotion of decentralised generation and storage projects (battery storage plant Schwarze Pumpe)
Goal: Lusatia has been developed into a model region for the hydrogen economy. Fields of action: - Use funding measures, e.g. from the BMVI's HyStarter programme. - Prepare for expansion to HyExpert status - Support regional networking (e.g. promotion and institutionalisation of the DurchH2atmen network). - Promote supraregional and interdisciplinary cooperation
Future field: Economic promotion and development Category of action: agricultural, forestry and fisheries value chains
Goal: Lusatian agriculture is climate-neutral and an innovation and model region for decentralised energy production through energy farming. Fields of action: - Combining agriculture, security of supply, resource protection and climate neutrality - Integrate energy crops into heat and energy production in an ecologically sensible way - Promote agroforestry systems and other technologies - Create incentives for the renewal of biogas plants and the intelligent integration of plants into the village structure, e.g. for district heating supply.
Goal: A competitive forestry and wood cluster contributes to regional value creation and the permanent substitution of a climate-damaging use of resources. The share of wood and wood residues as climate-neutral energy sources for decentralised energy and heat generation is significantly increased. Fields of action: - Develop durable products for the world market - Develop research capacities and large-scale technical facilities for innovative products and wood use - Further develop cluster management and network, also with neighbouring regions in Poland and the Czech Republic - Exploit the potential of power plant facilities and infrastructure - Develop Lusatia as a bioenergy region, create regional economic cycles for biomass

3.2 Key guiding principles

The Development Strategy Lusatia 2050 (Entwicklungsstrategie Lausitz 2050, Wirtschaftsregion Lausitz GmbH, 2020) is developed by a civil society organisation called *Wirtschaftsregion Lausitz GmbH*. The strategy is well known by politicians and local stakeholders and reflects the approaches of national and EU policies.

4 Support framework for R&I in Energy and Environment

4.1 Multi-level governance structure for R&I policies in Lusatia

The administrative structure in Germany is organised federally. Therefore, different levels of legislation exist. The federal government basically gives general directions and defines a legal framework. In the case of Lusatia, the Federal states of Brandenburg and Saxony are guided by this and can formulate special aspects and detailed implementation rules..

Germany, 7th Energy Research Programme

At federal level, the 7th Energy Research Programme aims to support the research and development of new technologies for future energy supply by companies and research institutions in Germany (Ministerium für Wirtschaft und Energie, 2018). It defines the current priorities of the funding policy for innovative energy technologies and is supported by the three Federal Ministries for Economic Affairs and Energy (BMWi), Education and Research (BMBF) and Food and Agriculture (BMEL). It was established under the leadership of the BMWi.

While the government's goal was still to reduce greenhouse gas emissions across Germany by at least 80 per cent by 2050 compared to 1990 levels when the programme was adopted in September 2018, the *Climate Protection Act of August 2021* aims to reduce them by at least 88 per cent by 2040. From 2050, even negative greenhouse gas emissions are to be achieved, i.e. the sequestration of greenhouse gases is to exceed their emission. The use of renewable energy sources in electricity production, biomass and geothermal energy in heat supply, as well as electromobility, alternative drives and a fuel mix with, among other things, synthetic fuels in the transport sector are an important part of the strategies for achieving the goals. At the same time, energy consumption is to be reduced drastically and energy efficiency increased significantly in all demand sectors.

Brandenburg, Energy Strategy 2030

The federal state government of Brandenburg adopted the *Energy Strategy 2030* in 2012 (Ministerium für Wirtschaft, Arbeit und Energie, 2012). As a result of an evaluation of the strategy in 2016/2017, an updated catalogue of strategic ones was adopted in July 2018 (Ministerium für Wirtschaft und Energie, 2018). The strengthening of the energy industry research landscape in Brandenburg is listed as one measure in it.

The objectives of this measure are to network science and industry and expanding technology transfer, to network and coordinate Brandenburg's research landscape, to promote the settlement of new research institutions and research-active companies, to increase the visibility and competencies of R&I and to initiate and increase the use of state-specific and supraregional funding approaches by Brandenburg companies and science institutions. Responsibility lies with the Ministry of Economic Affairs and Energy (lead) and the Ministry of Science & Research.

In addition to other specific tasks in this measure, the two ministries want to provide information on supra-regional funding approaches and programmes at federal and EU level. The *Investitions- und Landesbank* (ILB) (Brandenburg Reconstruction Bank) is the point of contact for the application, administration and processing of funding projects.

Saxony, Energy Research Master Plan

Research related to energy also takes place in Saxony. It is concentrated, in the areas of materials research, cooling and heat coupling, storage technologies, fuel cell research or energy efficiency in production, for example.

The state's *energy and climate protection programme* from 2012 (Saxonian State Ministry of Economics, Labour and Transport, 2013) defines the goal of promoting the research capacities available in Saxony in the area of regional climate and climate impact research, building up comprehensive education for sustainable development and supporting cooperation between the actors in the various areas.

In the federal state, the *Energy Research Master Plan* was launched in 2018 (Sächsisches Staatsministerium für Wissenschaft und Kunst & Sächsisches Staatsministerium für Wirtschaft, Arbeit und Verkehr, 2018). It is intended to map the strengths and weaknesses of Saxony's energy research landscape and its technology transfer potential on the basis of an analysis of the political and funding programme framework conditions. The specific tasks of the master plan are to map all central topics and key issues of the Saxonian energy research landscape, in particular also taking into account the expansion and promotion of an infrastructure of decentralised storage and power generation technologies, to work towards the nationally and internationally even more noticeable networking of Saxonian research actors, to improve the acquisition of third-party funding on the part of Saxonian energy research actors and to list measures for the increased transfer of innovative ideas and concepts from energy research. The universities, institutes and companies involved in the topic in Saxony were included in the development of the recommendations for action in the master plan.

As a result, the *Competence Centre for Energy Research* was established in Saxony, which is located at the *Saxon Energy Agency - SAENA GmbH* on behalf of the Saxonian State Ministry for Energy, Climate Protection, Environment and Agriculture.

The *Sächsische Aufbaubank* (SAB) (Saxonian Reconstruction Bank) is responsible as contact for the application, administration and processing of funding projects in Saxony.

4.2 Funding opportunities

Federal level

Within the framework of the funding announcement *Applied non-nuclear research funding in the 7th Energy Research Programme "Innovations for the Energiewende"* of June 2021, funding can be applied to support project-related activities in the field of research, development and innovation by companies, universities and research institutions, associations and foundations as well as regional authorities and public administration institutions (Ministerium für Wirtschaft, Arbeit und Energie, 2021). The guideline identifies the five sections *Energy Transition in the Consumption Sectors*, *Energy Generation*, *System Integration*, *Cross-System Research Topics* and *Other Measures* with numerous potentially eligible research topics. Examples of potential research topics are: Development of innovative technologies for hydrogen production, energetic use of biogenic residues and waste materials, further development of alternative PV materials and concepts or scalable technological processes and economic concepts for CO₂ capture, storage and reuse.

Funding projects are processed by the *Project Management Organisation Jülich (PTJ)* of the Federal Ministry for Economic Affairs and Energy (BMWi).

The grants are awarded as project funding and non-repayable subsidies, usually as partial funding. Universities and certain extramural research institutions may also receive 100% funding of the eligible project-related costs.

Another reference to research in the energy sector is the funding programme *Renewable Resources* of the Federal Ministry of Food and Agriculture (Bundesministerium für Ernährung und Landwirtschaft, 2015). One focus of the programme is research on and with bioenergy along the entire value chain - from the cultivation of renewable raw materials to the generation of renewable energy. The project executing agency is the *Fachagentur für Nachwachsende Rohstoffe e.V. (FNR)*. Depending on the type of research, the maximum grant amounts can range from 70 percent to 100 percent of the eligible costs. Natural or legal persons are eligible as grant recipients.

Brandenburg

The Federal State of Brandenburg itself does not provide any funding in specific programmes related to energy research. However, the state indirectly supports research activities through institutional funding of research institutions, such as the *FIB – Forschungsinstitut für Bergbaufolgelandschaften e.V.* (Research Institute for Post-Mine Landscapes).

Saxony

Like Brandenburg, The Federal State of Saxony does not fund energy research through programmes specifically defined in terms of content, but primarily through a state share of institutional funding for scientific institutions for energy research as well as the state share of project funding (ESF and ERDF), the majority of which is financed by Europe.

The *Sächsische Aufbaubank* (SAB) is the development bank responsible for granting and administering funding.

4.3 Priority areas for Research and Innovation

See Section 3.1: Development Strategy Lusatia 2050 (Entwicklungsstrategie Lausitz 2050, Wirtschaftsregion Lausitz GmbH, 2020)

4.4 Evaluation and Monitoring

See Section 3.1: Development Strategy Lusatia 2050 (Entwicklungsstrategie Lausitz 2050, Wirtschaftsregion Lausitz GmbH, 2020)

5 Concluding note

Basically, the research landscape in the predominantly rural region Lusatia, is relatively well positioned and offers a lot of potential, both in terms of innovations and new developments in the field of energy, and as an employer for highly qualified people. The greatest challenge facing the state governments in the coming years will be to maintain, strengthen and further expand the existing structures. Two decisive factors will probably be, how the region can present itself as an attractive location for innovative companies on the one hand and as an attractive employer region for highly qualified potential employees on the other.

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Annex

Minutes of the workshop "Photovoltaic systems on agricultural land in post-mining landscapes"

Date: 17.11.2021; 10.30 - 16:00

Location: Lichterfeld, "Aquaforum" conference boat on residual lake "Berheider See", nearby exhibition mine "Besucherbergwerk F60"

Participants: see attached list

- Introduction of participants
- Introduction and opening remarks from Ms. Wüstenhagen (LEAG) and Mr. von Oesen (LEAG) on the topic of renewable energies, particularly photovoltaics (PV) on reclaimed agricultural land as a promising business field for the mining company LEAG against the backdrop of the decided coal phase-out at latest 2038
 - maintaining and improving the mining-influenced land with generating an additional profit with PV systems, addressing basic questions about soil fertility, reclamation demands and costs, possible combinations of PV and agriculture

Presentation 1: Overview of the study of PV systems on agricultural land (FIB, Dr. Anne Rademacher)

- Presentation of the TRACER project – positioning Lusatia as a "green" energy region of the future
- PV systems a building block for achieving climate neutrality by 2050 (Paris Agreement, EU "Green Deal")
- Criteria for the choice of location according to the "Preliminary recommendation for action by the MLLK Brandenburg (Federal Ministry of Agriculture, Environment and Climate Protection) to support municipal decisions for large-scale PV-FFA" (03/2021)
- Development of mine dump soils over the reclamation period, initially in the start-up rotation, further increases in profitability in the following decades
- Agricultural use stipulated in the mining plans, also to secure the income of the farms
- Solution through multiple-use concepts such as Agri-PV (combination of agriculture and photovoltaics in the same field)
- Various construction-dependent arable and plant cultivation aspects
- Grazing / grassland:
 - Row spacing
 - Wolf-proof fencing, mains connection for electric fence device, cable protection, lower edge of the module at least 1m from the ground
 - Grassland quality, fertilisation, harvesting technology
- Arable:
 - Coordination of the management technology with module spacing
 - Headland dimensions
 - Cultures that do not produce shading
 - Harvesting technology
 - Special crops possible for small areas

- Communal needs to be considered in order to increase social acceptance

Presentation 2: Legal planning framework for ground-mounted PV systems (BPM Ingenieurgesellschaft mbH, Michael Kühfuss)

- Three important German laws: Federal Building Code (BauGB), Federal Land Utilisation Ordinance (BauNVO) and Ordinance on Symbols Used in Land-Use Plans (PlanZV)
 - All subject to EU laws, such as promoting climate protection etc.
 - A multitude of guidelines are incorporated into building legislation
- BauGB:
 - First part: preparation and definition of the legal quality of the soil and its usability at community level – consisting of a preparatory land-use plan and a legally-binding land-use plan
 - Second part: securing the planning / keyword "development freeze"
 - Third part: regulations determining the permissibility / building regulations in indoor and outdoor areas
- Environmental impact assessment: new environmental concern, "land" as a finite resource
- Municipalities can have a say in certain matters stipulated by the assessment catalogue (§9 BauGB)
- Planning sovereignty: administrative law of the municipalities has priority. Therefore, BauGB can strengthen the implementation of the independent development perspectives. To justify this status, participation from the public and local authorities is important in multi-stage processes – involvement at all levels.
- Consideration requirement: a central control instrument of the municipality, ultimately decided by the municipality council. All issues are considered and prioritised following participation and statements.
- Two stages of development planning (§1, 2 BauGB)
 - Preparatory land-use planning for the entire municipal area
 - then a binding land-use plan for certain areas of application in the municipality
- Two types of binding land-use plan: qualified (with a minimum stipulation) according to §30, 1 BauGB and project-related according to §30, 2 BauGB
- Planning process (see presentation slides)
- The preparatory land-use plan is not fixed; municipalities can also decide on a development plan (scope for interpretation of terms such as "outside / inside area")
- Specifics of PV systems on agricultural land:
 - Large area can be developed quickly (good from a planning perspective)
 - EEG limited to conversion areas and hard shoulder infrastructure until 2017, then expanded to include "disadvantaged areas" on arable and grassland areas
 - Important to safeguard agricultural interests with regard to the productivity of the soil, economic importance for agricultural operations, and agricultural areas with special importance for nature and landscape protection
 - Prevention of excessive use of agricultural or nature conservation areas
 - Combination of PV systems and nature conservation in low-yield locations
- PV systems are not allowed everywhere → the land-use plan is essential - municipal decision!

Presentation 3: Agri-PV as an opportunity for agriculture and energy generation (Fraunhofer ISE, Oliver Hörnle)

- Agri-PV: installing sufficient PV to meet the current targets would require 4% of the existing agricultural land
 - Low-hanging crops: take advantage of synergy effects between PV and agricultural production requirements: availability of light, systems adapted for specific plants and locations; preferably shade-tolerant cultures
 - Ideally, on-site use of the electricity generated on the farm – wide-ranging customised usage concepts available (PPA or grid feed-in, not EEG)
- Increased efficiency in land usage in order to expand the area available for PV. Greatest potential for arid areas or areas facing a scarcity of land.
- EU agricultural funding is not planned in Germany; there were several court rulings on this in 2021. Agricultural subsidies are likely to cover the area used for agriculture less the area covered by PV
- Difficult to obtain scientific yield data on agricultural crops under PV due to the lack of conclusive long-term test series (influence of weather and other variables)
- PV has good economic prospects
 - Costs for the substructure can be a deciding factor (elevated Agri-PV on arable land allows for conventional agricultural technology); fluctuates according to the current steel price
 - Lower operating costs as agricultural management reduces maintenance costs
- Funding for Agri-PV
 - Low-rise arrays applicable for EEG funding
 - Elevated systems more complex – share funding with parking lot PV and floating PV (less substructure necessary so cheaper per kWp than Agri-PV)
 - Horizon Europe – oriented toward research and development rather than practical agriculture
- Advantages of Agri-PV:
 - Microclimate (plant transpiration cools modules → increase in efficiency)
 - Less direct radiation on the ground (less transpiration, evaporation, sunburn, and drought stress)
 - Elevated systems with bifacial systems (sufficient reflection from the plants and soil) deliver high electricity yields
 - Potential replacement for polytunnels as protection from sun, hail or rain
 - Wooden substructures possible
 - Rainwater collection (V-shape of modules) and irrigation provision
 - Vertical systems with east-west orientation complement south-oriented ground-mounted PV

Presentation 4: Diverse concepts for PV systems (SUNfarming GmbH, Peter Schrum)

- Presentation of the SUNfarming Group
 - Business areas:
 - Project development for large solar parks
 - Direct electricity (municipal and commercial electricity, small and medium-sized roof-mounted systems)
 - FEED - Food, Energy, Education & Development (Solar greenhouses, food and medicinal herb production, training)
 - AgriSolar concept: dual use through cultivation of areas below and between modules
 - Modules do not exceed 3 m in height (in Germany, PV modules should be kept out of sight where possible)
 - Translucent glass-glass modules
 - Rainwater drainage between the modules, but also lateral distribution using a drip system
 - Grazing sheep (recommended edge of the module no lower than 1.50 m)
 - Free-range chicken reared in fenced areas under the modules (problematic in winter)
 - Cultivation of flowering plants (in combination with beekeeping), vegetables, special crops, etc.
 - Experiments with agro-robotics - less dust through tillage
 - Multi-layered solutions also depending on the availability of manual labour
 - Implementation with simplified technology in African countries
 - Possible to visit the SUNfarming training & research centre in Rathenow (Brandenburg)
 - Question: Is land ownership a prerequisite for the installation of Agri-PV systems? → No, potential solution via profit partnership with land owners

Presentation 5: Nature conservation aspects of ground-mounted PV (FIB, Ingmar Landeck)

- Effects of older PV systems investigated from 2011-2013
- Ground-mounted PV modules influence the distribution of various insects
- No uniform distribution tendency – species-specific distribution patterns
- Important to carry out an examination prior to the module installation in order to provide a meaningful before-and-after balance or to give species-specific recommendations for the design of the PV systems
- Open questions:
 - Do the modules cause a fragmentation of habitats?
 - Do PV systems promote biodiversity in the landscape with regard to bird species?
 - Design using open spaces or corridors?
 - Is the immigration of species atypical to the habitat problematic?

Final Discussion

- Management:
 - Agri robots can be a solution, dust reduction, mowing at a height of 30 cm, robotics is still being developed in some cases - market readiness in 2-3 years depending on the direction of use?
 - Regulation of disturbing plants such as black locust and sea buckthorn through regular mowing / mulching
- Special feature of tilting soils with very little humus:
 - Supply of organic matter, high cost factor
 - Shading positive for water content and soil development
 - Monitoring of soil development over 20 to 30 years' necessary
- Agri-PV systems:
 - Who is going to implement all these great ideas?
 - Crucial to cultivate interest from farmers' associations; promote early involvement from farms, integrate into the future of agriculture
- Ground-mounted solar park vs. Agri-PV systems:
 - Legal framework for agricultural subsidies not yet defined
 - Pure ground-mounted PV are more economically advantageous than Agri-PV, therefore funding and administrative regulators must be adjusted
- Construction:
 - No concrete foundations necessary, clean removal guaranteed by ramming in the posts into the ground. Also suitable for elevated systems such as the Fraunhofer pilot and demo project in Heggelbach (Baden-Wuerttemberg)– where the “spin anchor” was developed

Attachment

- List of participants