

Smart strategies for the transition in coal intensive regions

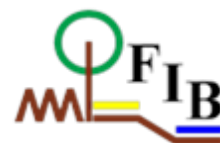
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Blueprint on Lusatia's energy transition

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Executive summary

Lusatia is still a predominantly rural region. Although 150 years of industrial lignite mining and refining have left deep traces in the landscape, there is no coherent industrial area or urban agglomeration – in contrast to other mining regions in Europe like Upper Silesia, Poland or Donetsk, Ukraine. However, due to a long experience in mining, power generation and refining the target region is relatively well positioned for the ongoing structural changes and offers a lot of potential, both in terms of innovation and new development in the field of energy, and as an employer for highly qualified people. The greatest challenge facing the touched federal state governments Brandenburg and Saxony in the upcoming years will be to maintain, strengthen and expand the existing structures and technological know-how, against a continuing trend of demographic decline and over-aging of the society (TRACER-D 6.2, 2022).

The projections for the energy-mix are going back on Germany's first climate protection plan, which aims to reduce greenhouse gas emissions by at least 55% from 1990 levels by 2030 at the latest. There is a focus on strengthen the renewable energies, especially (agro) photovoltaics (TRACER-D 6.1, 2021). However, a big challenge in Lusatia is an expected deficit of around 75,000 workers by 2030 due to demographic development and a shortage of about 120,000 workers until 2050.

Thereby, in contrast to other industrial regions reskilling and retraining only play a subordinate role (TRACER-D 6.3, 2022). The focus is on recruiting new workers ("performers") through immigration and reducing the emigration of potential skilled workers. The attractiveness is to be achieved through improved services of general interest in rural areas and a stronger identification and marketing of Lusatia's traditional roots. And the region has many soft location plus points: the „good life“, away from big city rush, noise, fine dust and unaffordable rents and living space.

But the two decisive factors will probably be, how the region can position 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. The stepwise transformation process is in several levels already underway, with different active stakeholders from politics, administration, rural and municipal development, economy/trade, R&I and civil society.

1 Lusatia's common vision statement

As a result of the structural strengthening process, the Lusatian mining area will be a CO₂-neutral economic area. Existing economic structures have been further developed in line with a green industry approach. Through the anchoring of new technologies, sustainable value chains were established in the region in the long term.

The Lusatian district will be:

- a European model region for structural change,
- a central, European interlinked region,
- an innovative and efficient economic region - CO₂-neutral,
- a modern and sustainable energy region,
- a modern location for research, innovation and science, a model region for health that links research, teaching and care in a new way using digitalisation, and
- a region with a high quality of life, cultural, linguistic, ethnic and sporting diversity and intact natural areas (Wirtschaftsregion Lausitz GmbH, 2020).

In Lusatia, the Development Strategy Lusatia 2050 (Wirtschaftsregion Lausitz GmbH, 2020) is an already existing and orienting strategy for medium- to long-term development in the region, which places emphasis on research and innovation, especially in the energy sector. The strategy was developed as a multistage "bottom-up" process (dialogue forum) and finalised in 2020. Around 5,000 randomly selected people from Lusatia were invited to contribute their ideas and perceptions in various public participation formats (workshops) – a representative cross-section of the population.

Moreover, a comprehensive collection of materials and already existing regional concepts were condensed to a joint development strategy for the whole mining region. More precisely:

- A milestone for the structural change: The mission statement formulated describes Lusatia as a CO₂-neutral economic area in which existing economic structures have been evolved in the sense of a green industry approach. By anchoring advanced technologies like fuel cell, battery storage and hydrogen, sustainable value chains could be established in the region in the long term.
- The fixed strategy is intended to form the coordinated framework for shaping a sustainable Lusatia. Adequate job opportunities and an intact living environment are an important basis for the success of structural change.
- When looking at the transformation process in all 9 TRACER model regions, it can be stated that Lusatia is going ahead, having already some experience in structural change, adaptation and reinvention – starting with the hard structural break in the 1990s, followed by disillusion to the organised change and new awakening nowadays.

Consequently, there is no need and it makes no sense to develop within TRACER a separate – somehow new or adapted – strategy or roadmap together with stakeholders in the region. Instead, the relevant contents of the Development Strategy Lusatia 2050 are presented here, with some additional comments: What is promising and has already been achieved since 2020, or whether it is on the right track (or no). Thus, any roadmap for transition is only a current "snapshot", and has to be updated regularly and step-by-step, regarding the achieved results, recent development, new initiatives and changing framework conditions. This is the aim of the work done herein.

The delivered results are convincing – even to sceptics – and give courage to people. Contrary to previous predictions, the emigration of young workers, especially in the rural sub-regions, seems to be stopped. After three decades of labour oversupply and unemployment, the Region is now facing skills shortage.

Despite still existing barriers, politics and media are already talking about a new booming region, Lusatia. After years of uncertainties regarding the coal phase-out, the tipping point is now overcome. Also, the Lusatian "success stories" change the public opinion: Structural change in coal regions offers opportunities – for both humans and the environment! A self-fulfilling prophecy?

Thus, the transition process in Lusatia started already and picks up speed. There are many regional activities, strategy developments and programmes ongoing, parallel, on different levels of action, responsibilities – but unfortunately, in general less coordinated so far. Even more, there is a strong need for a well communicated transition process by the government in the affected Federal States of Brandenburg and Saxony, which is shaped in consideration of all aspects. It makes more sense for TRACER activities to align with existing strategies and programmes, than creating another "artificial master plan" for transition without adhesion and chance of political implementation. Thereby, FIB sees TRACER within a communication process – a platform, especially for less represented stakeholders to play a part in the actual discussion about the future of the region. Thus, one crucial point is that their concrete needs and expectations are considered.

2 Lusatia's projection of the energy mix

In Germany the two most important fossil primary energy sources are oil and gas. Oil is mainly used in the transport sector as fuel (BMW, 2020), but it is still used for heating and warm water production in the building stock. Nevertheless, the market share of oil heating systems has been falling since 1998. This illustrates the increasing displacement of oil-fired systems from the market and the decline in importance of heating oil in heating supply (DENA, 2016). About 75% of the new installed heating systems were based on gas in 2015 (DENA, 2016). In new buildings, the heat pumps have the second largest share of heat generators at 30%. In the existing buildings, the heat pumps play a minor role at 4% (DENA, 2019). The importance of heat pumps in the construction of single- and two-family houses will increase significantly in the coming years (DENA et al., 2017).

In line with EU "New Green Deal", its purpose is to reduce and end the generation of electrical energy through the use of coal in a socially acceptable, step-by-step and as steady as possible manner in order to reduce emissions, while ensuring a safe, inexpensive, efficient and climate-friendly – in its best "sustainable" – supply of electricity. The remaining net nominal electrical output of systems for generating electrical energy through the use of coal should therefore be reduced gradually and as steadily as possible, as follows:

- in the year 2022 to 15 gigawatts (GW) of hard coal and 15 GW of lignite,
- in the year 2030 to 8 GW of hard coal and 9 GW of lignite and
- at the latest by the end of the year 2038 to 0 GW of hard coal and 0 GW of lignite (TRACER-D 6.1, 2021).

The strategy was to use gas as bridging energy source until the energy production is secured by renewable energies. Actually, Germany has gas-fired power plants with a gross capacity of approx. 30 GW in operation. This amount will increase to around 37 GW by 2040. Gas power plants have the advantage that they can be deployed flexibly and used as peak load power plants (Ammon et al., 2019). Thus, gas has an increasing importance in the German energy supply in the coming decade. The change in the political situation puts this strategy into perspective. In the short term, the construction of first LNG terminals is being implemented in order to secure the gas supply from other providers. These terminals are probably useable by hydrogen as well. Thereof, it is difficult at the moment, to make reliable projections on the implementation of concrete investments in the regional energy sector for the upcoming 30 years.

Projections for the Lusatian region must consider national and European goals and regulations. The European Council agreed to reduce greenhouse gas emissions by at least 40% within the EU, as well for Germany, by 2030 compared to 1990 levels. Brandenburg had adopted an "Energy Strategy 2030" already in 2012. It was evaluated in 2016/2017 and an updated catalogue with measures was released in 2018. A main goal in reducing energy consumption is to increase the share of renewable energies in final energy consumption by up to 40% (MWAE, 2021). Electricity from windmills, solar modules and biomass power plants are the primary technologies here. The final energy demand for electricity shall decrease by 9% from 2007 to 2030 and shall be covered 100% by renewable energies. Heat consumption shall drop by almost 34% by 2030 compared to 2007 due to efficiency improvements in the industry, thermal insulation measures in private households and others. The share of renewables in the heating demand shall increase to 39%.

An energy and climate programme was adopted in 2012 also in Saxony, which is currently being revised (SMWA & SMUL, 2013). The report outlines expansion targets for various renewable energy sources for the next 10 years – i.e. until 2022. In the area of electricity generation, the focus was particularly on the expansion of solar energy to provide 1,800 GWh/year (from 900 GWh/year in 2012). The use of biomass for electricity generation is to be increased to 1,800 GWh/year (from 1,385 GWh/year in 2012). An expansion of wind energy to 2,200 GWh/year (from 1,700 GWh/year in 2012) was also planned.

Saxony aims to develop an "Energy and Climate Programme 2020 – 2030" and to publish it within the next month (SMEKUL, 2021). The most important point of the concept will be the expansion of renewable energies. Additionally, 4 TWh of electricity shall be generated from renewables annually until 2024, by 2030 it shall be additional 10 TWh annually. In 2017, the power generation from renewable energies was about 6 TWh (6 billion kWh). 20.4% of the gross electricity consumption in 2016 was ensured by renewable energies.

In spite of all prognostic uncertainties, a coordinated, consistent and overall binding roadmap / master plan for Lusatia's energy transition as a whole – apart from the decided coal phase-out and successive decommissioning of lignite mines and coal-based power plants – is still missing. Up to now, there is no statistical data preparation for the target region across the federal borders. The same applies for action plans, which are in general on a federal state scale. What is striking: Currently Lusatia is in a wide-ranging consolidation, orientation and reinvention phase – not only considering the energy sector and transition. In the last 150 years of lignite mining has been the closing clamp, and there is still missing a new regional and lived identity. But Lusatia is much more than a discontinued model or an extended workbench. The single steps and actions in transition are uncertain – but what is definite are the targets set:

- The share of wind and solar power in total electricity production is to increase significantly. They will dominate and shape the system. Biomass will contribute to a limited extent to energy supply by 2050, mainly based on the energetic use of waste and slurry, digestate and residues, in local applications to provide thermal energy for the industrial sector, commerce, trade and services, and the heating sector.
- Combined heat and power generation (CHP), preferably based on natural gas, is to continue to play an important role. It is becoming increasingly flexible, with lower emissions, and should increasingly integrate renewable heat production.
- Decarbonisation in the electricity sector will be driven by energy efficiency and the expansion of renewable energies. In the areas of heating and cooling as well as in transportation (propulsion), the emission reductions by 2050 can only be achieved if the energy demand is covered with electricity from renewable energies – as is the case, for example, in heat pumps, electric vehicles.
- In addition, sector coupling can provide more flexibility in the electricity market if demanders in the heat and transport sectors increase or reduce their demand by

many gigawatts very quickly. Fluctuations in the electricity supply from wind or sun can thus be balanced out.

- The "Climate Protection Action Programme 2020" (BMU, 2014) sets out a strategy for climate-friendly construction and housing with the aim of getting cities and communities climate-neutral by 2050. This requires both demanding new building standards, long-term renovation strategies for the existing building stock and a move away from fossil heating systems.
- For new buildings, the lowest-energy building standard ("Niedrigstenergiestandard") that is applied since 2021, and gradually further developed. New installations of heating systems that make efficient use of renewable energies will then be significantly more attractive compared with heating systems using fossil fuels. To this end, suitable incentives will be examined for the use and construction of buildings that generate more energy than is required for operation.
- Existing buildings are also to be renovated by 2050 through energy efficiency measures and increased use of renewable energies in such a way that they meet the requirement of a virtually climate-neutral building stock. If new heating systems are installed or replaced in existing buildings, appropriate incentives must be put in place to ensure that as much heat as possible is provided by renewable energies.
- In 2050, the transport system is to be virtually independent of fossil carbon fuels and thus largely greenhouse gas neutral. The vision also includes a transport system in which air pollutants and noise emissions will be significantly reduced and land consumption will be lower than today.
- Mobility will change fundamentally through automation and networking. Digitisation will make it possible to increase efficiency. Increasingly automated and networked mobility will optimise traffic flows and promote congestion avoidance, thus helping to save energy. Rush-hour traffic is to be reduced with the help of modern forms of working (home office, mobile working). Logistics processes are to be further optimised and the number of necessary transports reduced.
- The energy supply of road and rail transport, as well as parts of air and sea, is to be switched to biofuels and, otherwise, largely to electricity from renewable sources and other GHG-neutral fuels.
- Combustion engines are an indispensable option in the switch to alternative drives or energy sources. As fuels, *eFuels/Power-to-X* are to be increasingly used. The GHG quota sets clear incentives for the use of biofuels with relatively high GHG reduction values. This stimulates a development towards advanced biofuels mainly based on residues and waste materials and with high GHG reduction values.
- For those applications where electricity cannot be used directly, for example in aviation, biogenic fuels can play a role. The energy system, which is geared to renewable electricity, is intended to combine the electricity, transport and heating sectors, which are still separate today, into an efficient overall system in which the energy infrastructures are also coordinated with one another (sector coupling).

According to the *Development Strategy Lusatia 2050* (Wirtschaftsregion Lausitz GmbH, 2020) with projections up to 2050, the goals are:

- 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.
- 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.

- 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, reclamation and volarisation of otherwise underutilised land, circular economy, decarbonised energy production and energy storage systems.
- The energy supply remains competitive, and there is security of supply in the energy sector. Lusatia turns into a model region for the hydrogen economy.
- Lusatian agriculture is climate-neutral and an innovative model region for decentralised energy production through energy farming.
- 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.

A more detailed list of the goals and fields of action is available in Research & Innovation Strategy in the field of Energy for Lusatia (TRACER-D 6.2, 2022), the focus being strengthening the sector of the renewable energies (photovoltaics and wind energy) and establish power-to-X technologies.

3 Lusatia's available options meeting the planned energy transition

Lusatia is still a quite structurally weak area – as compared to other regions in Germany, which is affected by ongoing emigration and rapid demographic aging. There are new visions for the development of the region in future. This process has already started (Lusatia as energy, industry and service region, touristic destination, etc.) and will probably be evaluated within the next years - it is not time for resignation but a positive approach. Moreover, it is necessary to integrate the inhabitants of Lusatia in the process of developing new business ideas and concepts - bottom-up-approach. For the ongoing development towards the coal phase-out the region Lusatia needs to use all economic and creative potentials within the region and work together with neighbouring areas, sharing their know-how and best practice (TRACER-D 3.4, 2020). Important for the companies and local employees is a well-planned structural change with reliable strategies for alternative businesses on a sustainable medium to long-term perspective. A big aspect is, that the Lusatian region is expected to lose 17% of their inhabitants by 2040 (Markwardt et al. 2016). In addition, the average age of the population will continue to rise (to 54 years in 2040). The authors therefore forecast a shortage of about 120,000 labour force members in the medium and long term (TRACER-D 6.3, 2022). Moreover, the regional development strategy 2050 sees Lusatia as a (green) energy region with trendsetting technologies, developing recycling economy and an additional regional value chains. Overall, this positioning offers good job perspectives, especially for young workers, even without special training programmes for employees leaving the coal industry. The stepwise transformation process is already underway.

One big advantage of the "coal countdown" and upcoming challenges in the next 18 years is, that the economic and social transition process is plannable and controllable ahead. There are plans of strengthen the sector of renewable energies like photovoltaics (TRACER-Fact Sheet, 2019a) and wind energy (TRACER-Fact Sheet, 2019b). Actually, the Lusatian post-mining landscape and especially agriculture land are already a hot spot for renewable energies. There are already approx. 1,000 MW (megawatts) rated power solar energy and 1,000 MW wind energy installed, and according to conservative estimates there will be in total 4,000 to 5,000 MW up to 2030. This is also a strong plea for combined land use systems, (1) addressing the global sustainability goals, (2) creating an additional regional

value added on otherwise underutilised land and (3) having a high public acceptance – “energy landscape” with a real win-win-win-situation.

Relating thereto, another big topic are storage technologies like “BigBattery Lausitz” (TRACER-Fact Sheet, 2019c) and Power-to-X (TRACER-Fact Sheet, 2019d), especially hydrogen technologies. When talking about green electricity consumption and transformation again the value-added has to be in the region. Investments and founding's are going in all these sectors.

Lignite reclamation – a Lusatian success story

The land taken by mining, in over 150 years of industrial coal mining, includes 879 km²; of which 557 km² are reclaimed lands. The main environmental challenges are:

- the complete destruction and remodelling of the pre-mining landscape in a geological dimension;
- acid-sulfurous (pyrite / maracasite, (FeS₂)-containing) substrates, acid mine drainage (AMD) and acid salt leaching (ASL) with a strong impact on the surrounding landscape (groundwater, downstream quality)
- Geo-mechanical instabilities of sandy textured spoils and embankments, sudden liquefaction of dumps due to rising and surface-near groundwater

But the reclamation is well doing, geological instable caved area is only local, caused by abandoned (historical) lignite deep mining (second half 19th century, early 20th century), with no landscape relevance. The backfilling of shafts and mines is almost completed. There is no general barrier for regional structural development (TRACER Best Practice Factsheets “Chemistry Park Schwarzheide” (2019e), “Industrial park Schwarze Pumpe” (2019f), TRACER-D 2.5, 2019 and TRACER-D 3.3, 2020). In fact, Lusatian lignite reclamation and remediation are going ahead, when talking about a sustainable structural change – a success story, may be a blue print for other European coal region in transition, considering all aspects: reclamation planning, public participation, technologies, accompanying & applied research.

4 Lusatia's high priority measures and concrete actions

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 Brandenburg and Saxony implement the legal framework and have sufficient leeway for state-specific features and implementation of detailed regulations. So far, there are no reliable and consistent data for the economic region Lusatia as a whole, also because the core area affected by mining depends to two federal states with different administrative bodies. The ability to plan and trace the expansion of, for example, photovoltaics on open spaces is valued, since land use planning is a municipal task (urban land-use and development planning). On the other hand, there are overall targets that relate to the federal territory or the state areas – but not specifically to Lusatia as an economic and structure change region. Therefore, at the moment any serious assessment of the expansion of the individual energy sectors and the job creation potential during the decarbonisation process cannot be derived. Moreover, the recent energy crisis due to natural gas and crude oil supply bottlenecks makes forecasts very uncertain.

Within the last years, a civil society organisation so-called Wirtschaftsregion Lausitz GmbH worked out the *Development Strategy Lusatia 2050* following a very intense participation

process. The strategy considers aspects of the federal states of Brandenburg and Saxony and reflects the approaches of national and EU policies. As it is the outcome of an interactive process and broad public discussion considering the lessons learnt from the structural break in 1990, it is well known by politicians and local stakeholders.

According to the *Development Strategy Lusatia 2050*, the Lusatian mining area will become – as a result of the structural strengthening process – a CO₂-neutral economic area, which looks like rather ambitious and hardly imaginable today, but possible when taking seriously the European Green Deal (2019). Therefore, existing, well performing economic structures and “hidden potentials” have been further developed, now in line with a green industry approach. In the region there are new technologies established and sustainable value chains created in the region on a long-term basis.

The *Development Strategy Lusatia 2050* defines the priorities of action for the adequate implementation of the mission statement:

- **Priority 1:** Strengthening and development of the competitiveness of business
- **Priority 2:** Development and establishment of the regional brand Lausitz/Łužica/Łužyca
- **Priority 3:** Strengthening and development of life quality

Specification of the set of actions required to implement the Roadmap

For a brief overview, the main focus points on which the strategy is aimed are mentioned here. A detailed description of the individual measures to achieve these priority goals can be found in the [development strategy](#) (Wirtschaftsregion Lausitz GmbH, 2020).

- **Priority 1:** Strengthening and developing the competitiveness of business
 - Innovation, research, science to build sustainable value chains
 - Stabilisation of existing companies
 - Realise business settlements
 - Development of business-related infrastructure
 - Securing skilled workers
- **Priority 2:** Development and establishment of the regional brand Lausitz/Łužica/Łužyca
- **Priority 3:** Strengthening and development of life quality
 - Culture and arts
 - Social infrastructure
 - Tourism
 - Protection of the environment and nature
 - Sports

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ANNEX - Blueprint Benchmark of Lusatia Region

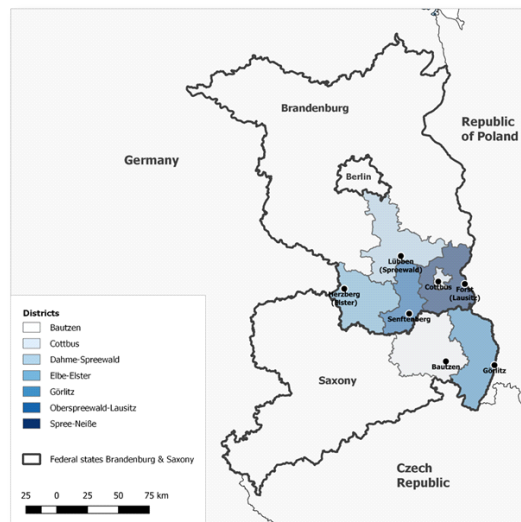
GERMANY

Brandenburg (DE 40) & Dresden (DE 02)

Lusatian Lignite District / Economic Region Lusatia

	2017 - 2020
SURFACE (km ²)	11,582
POPULATION (inhabitants)	1,162,703
GDP PER CAPITA (EUR)	26,307

Source: TRACER-D 3.1, 2019



	2017 - 2020
DIRECT EMPLOYMENT IN THE COAL INDUSTRY (power and/or heat generation, mining) (pers.)	8,600 + 12,000 (related industries)
UNEMPLOYMENT RATE (%)	10.1

Source: TRACER-D 3.1, 2019

LUSATIA COAL PHASE-OUT SCHEDULE – INSTALLED CAPACITIES (GW)

POWER GENERATION FACILITIES	2022	2030	2038
Hard-coal based	15	8	0
Lignite based	15	9	0

Source: TRACER-D 6.1, 2021