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REINVENTING SAXONY.

OPPORTUNITIES AND CHALLENGES FOR SAXON INDUSTRY

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Executive Summary

Reinventing Saxony. In keeping with this tradition, the analysis above is an account of the opportunities and challenges of sustainability for Saxon industry, using the method of scenario planning[1] to develop the contours of a sustainable future for Saxony. Based on the SWOT analysis and global megatrends, four future scenarios have been identified (see **Fehler! Verweisquelle konnte nicht gefunden werden.**) and give rise to the following twelve theses:

Future 1 Groundbreaking projects

Thesis 1: Raising resource and energy efficiency of manufacturing processes minimizes environmental impact while maximizing cost savings.

Thesis 2: A proactive approach to the challenges of sustainability makes for innovative product development and promotes expansion into new markets.

Future II Digital Engineering

Thesis 3: Digitization allows for spatial separation of employees and employers.

Thesis 4: Digitization facilitates worldwide cooperation regardless of location.

Future III From the region, for the region

Thesis 5: Appreciation of regionally manufactured products raises the location's appeal.

Thesis 6: Demand for individualized consumption requires a unique selling proposition to create customer proximity

Future IV Value creation through industry support services

Thesis 7: Service offerings within a shared economy environment facilitate economic success without additional resource consumption.

Thesis 8: In a circular economy, more effective and efficient use of resources extends the useful life of products.

Infrastructure is the key factor in all futures:

Thesis 9: An attractive public transport system connects jobs, residential and recreational areas.

Thesis 10: Cities and rural areas boast a globally competitive digital infrastructure

Thesis 11: The education system is designed to help workers acquire and continuously develop required skills.

Thesis 12: The health care system provides coverage for employees and their dependents including parents in need of assistance.

The goal of this analysis is to prepare the Free State of Saxony for the upcoming challenges and take advantage of related opportunities. Slow adjustment to megatrends has jobs disappearing faster than new jobs are being created. Therefore, it is

[1] Scenario planning is carried out in six steps under DIN SPEC 35811 (DIN German Institute for Standardization 2014).

recommended that state policies play a stronger role in today's transformation by promoting gentle structural change and sustainable development for the Free State of Saxony.

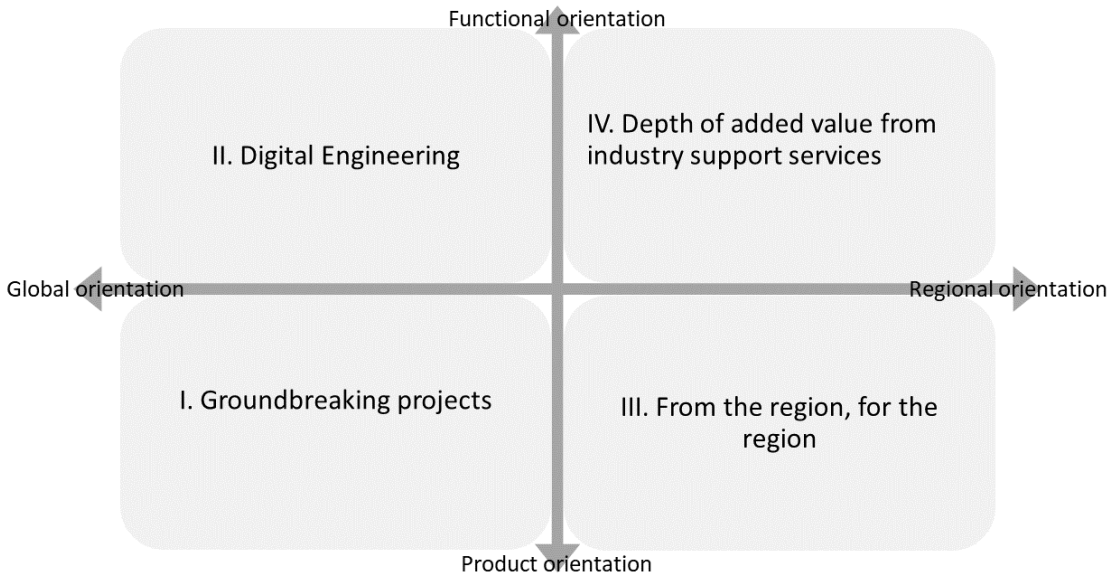

Fig. 1: Possible futures for Saxon industry

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1 Reinventing Saxony! Tradition and future

1.1 Tradition: Reinventing Saxony!

Whether porcelain, mechanical looms, tea bags or the daily newspaper - these innovations conquered the world and put Saxony on the map. Yet Saxons not only came up with technical but also with management innovations such as sustainable management: As early as 1713, the Saxon chief mining officer Hans Carl von Carlowitz described in his work "Sylvicultura Oeconomica" for forestry"... how to employ a sothane conservation and cultivation of wood/ so that there be a constant and sustainable use...". (Carlowitz 2000, p. 105). Today, Saxony continues to stand for innovative spirit and entrepreneurship, as exemplified in the development of organic LEDs, carbon concrete or lightweight construction[2] materials. The tradition of management innovations in sustainability shows no sign of waning either: At the interdisciplinary PRISMA Research Center for Sustainability Assessment and Policy[3], scientists from various disciplines put their heads together under the vision "Measuring and assessing sustainability".

1.2 Future: Reinventing Saxony!

In the footsteps of this tradition, the following analysis examines the opportunities and challenges of sustainability for Saxon industry in order to develop visions of a sustainable future for Saxony. This analysis is undertaken in the spirit of the mission of PRISMA (2017): *"We conduct research on sustainability assessment and policy, i.e. on the fundamentals of measuring and evaluating long-term development that is economically successful and ecologically and socially sustainable while taking into account spatial and temporal conditions, and fostering cross-disciplinary insights into politics, economics and society."* The analysis is followed by an appeal to business, the political arena and civil society: Let's reinvent Saxony!

2 Starting point

Following in the footsteps of the Saxon Sustainability Strategy of the Free State of Saxony (SMUL 2013), the first Saxony Sustainability Report (SMUL 2016) was issued in 2016. In the coalition agreement, the current Saxon state government commits itself to a "policy of sustainability that reconciles business interests with protection of the environment and social responsibility". (CDU State Association Saxony and SPD State Association Saxony 2014, p. 81).
The sustainability strategy of the Free State of Saxony has set eight *priorities*:

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[2] More examples can be found at the following link: https://www.so-geht-saechsisch.de/thema/arbeiten-und-erfinden/forscherdrang/) and here: https://tu-dresden.de/ing/der-bereich/news/smart-systems-hub-dresden.

[3] Information about PRISMA can be found at tu-dresden.de/prisma

- Our *"Sustainable Fiscal Policy"* seeks to reduce debt for future generations and maintain and expand the infrastructure underpinning the development of economic strength.
- *"Making education sustainable"* focuses on lifelong learning while promoting a sense of responsibility for the community and the environment. Herein lies an opportunity to develop awareness of sustainability as part of initial job training and in continuing education while harnessing the resulting potential for sustainable business models.
- Similarly, *"Harnessing and utilizing the potential of skilled professionals"* puts the focus squarely on people. In light of a skilled worker shortage, a shrinking workforce and increasing mental illnesses, the Saxon motto "Everybody Counts!" describes the impetus behind integrating job seekers into the labor market through targeted qualification programs, needs-based support and the expansion of efforts to improve workplace conditions that are conducive to mental stress. We seek partnerships between institutions of (higher) education and businesses. In parallel with the "Good jobs for Saxony"[4] concept of promoting better work conditions at small and medium-sized enterprises (SMEs), all actors are engaged in a dialogue through the skilled workers alliance.
- *"Maintaining Health and quality of life"* should be a principle that applies beyond working life. That's why a concept for senior care[5] has been developed for the Free State of Saxony. At the same time, we ensure that nursing care receives the recognition it deserves and age-appropriate assistance programs for independent living and telemedicine are being researched to improve medical care in rural areas. Prevention and support programs for children and young people provide the foundation for maintaining health.
- *"Guiding economic growth and innovation"* identifies areas where networking efforts on innovation between industry, administration and universities need to be intensified. The Free State of Saxony has a strong education, science and research landscape boasting 24 universities and 42 research institutions (including Fraunhofer, Max-Planck, Leibniz, Helmholtz) with a focus on microelectronics, nanotechnology, mechanical and automotive engineering, materials science and biotechnology. Most cooperation networks extend beyond regional borders. The share of R&D expenditure in GDP still remains below 3% and in Saxony 94% of that share is contributed by SMEs.
- An intact natural environment provides the foundation for economic and social sustainability. Saxony's focus on *"climate protection, efficient energy use and secure supply"* combined with *"Conservation of natural resources"* illustrates the

[4] Learn more at http://www.arbeit.sachsen.de/11580.html

[5] The senior care concept of the Free State of Saxony can be found here: https://publikationen.sachsen.de/bdb/artikel/11680/documents/12250.

state's dual strategy of climate protection and adaptation to climate change through measures that increase energy efficiency and protect natural sinks such as bogs, soils and forests. The Free State of Saxony supports thermal use of renewable energies and the development of storage facilities for a sustainable energy supply. There are financial incentives for energy-efficient renovation and passive construction[6]. Forest regeneration is in competition with agriculture and nature conservation. Residential development and transport have led to additional encroachment on land use. To avoid fragmentation, protected areas should be considered as an integrated system. The reduction of pollutants and nutrients in the water is also addressed in the sustainability report. At this point, however, only the treatment of household wastewater has been recognized as an indicator, which leaves other sources of input unaccounted for. In the Free State of Saxony, agriculture faces a major issue in the form of soil erosion and the resulting input of substances into bodies of water. Waste from opencast lignite mining is also polluting the waters, especially the Spree, giving rise to what is commonly referred to as chemical clogging[7].

- The motto *"Cities and rural areas step into the future together",* showcases the economic strength of the three population centers and two other regions with distinct profiles of value creation (Chemnitz-Zwickau: auto manufacturing; Dresden: ICT/microelectronics; Leipzig: auto manufacturing, creative and financial industries; also Erzgebirge/Vogtland: metal manufacturing; Görlitz: mechanical engineering and food industry). The regional profile also shows that the population as a whole, especially the working population, is on the decline except in Dresden and Leipzig. Along with technological change, these societal challenges impact above all metal production, mechanical engineering and the food industry. Integrated concepts targeting both people and businesses are designed to promote the vitality of cities and villages: On the one hand, quality of life must be enhanced through cultural offerings. On the other hand, an efficient public administration, demand-based building renovation, and an infrastructure adapted to future needs along with a long-term housing policy will go a long way towards improving the general business environment.

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[6] The Saxon Energy Agency provides advice on the funding schemes: http://www.saena.de/projekte/bauen.html

[7] The groundwater level must be lowered for the construction of open-cast mines. As open-cast mining is being phased out, the groundwater level usually rises and sulphate and iron are washed out of the soil. Iron oxidizes, turning into iron hydroxide. The resulting so-called iron ochre settles as mud at the bottom of the river, turning it brown.

3 Scenario planning method

In order to achieve the greatest possible transparency, overcome complacency about established traditions[8] and barriers to change including the so-called lock-in effects[9] and to get away from an overreliance on already existing technologies, procedures or thought patterns, this strategy paper employs the method of scenario planning.[10] It is structured along the six steps of the scenario approach (see

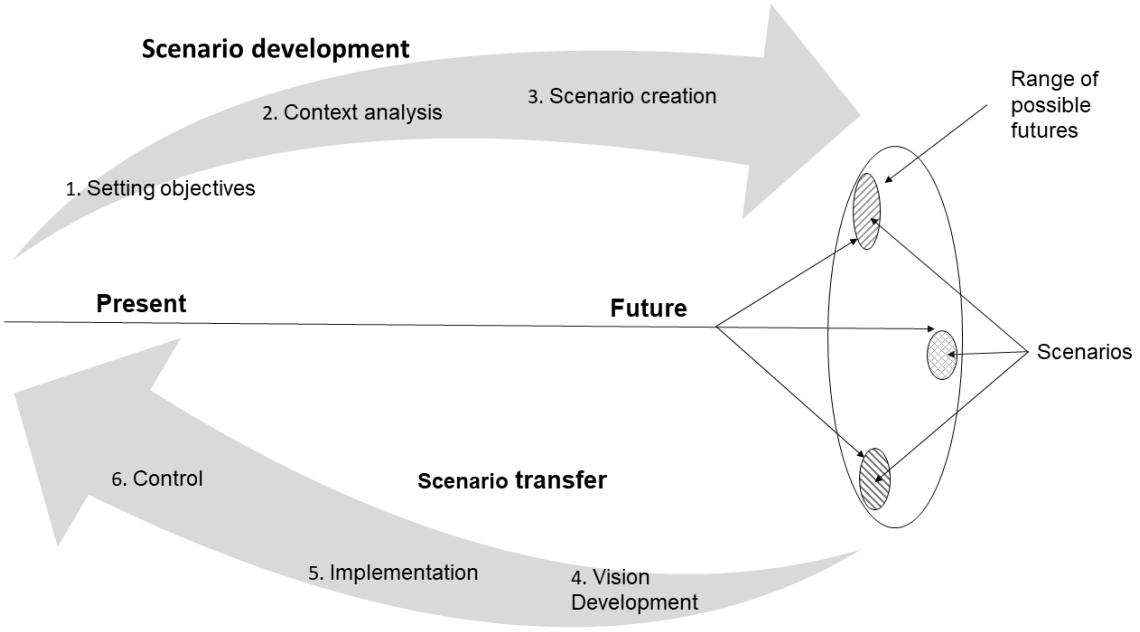

Fig. 2), followed by goal setting (see 4.1), an environmental analysis (see 4.2), scenario planning (see 4.3), vision development (see 0), implementation (see **Fehler! Verweisquelle konnte nicht gefunden werden.**) and control (see 4.6). Scenario planning assists companies in seizing future opportunities and handling challenges head-on. Uncertainties such as the financial crisis in 2008/09, digitalization, climate change or demographic change are continuing to pose new strategic planning challenges for industrial companies and policymakers in the Free State of Saxony.

Scenario planning generates various scenarios that use the present as a springboard for the future. It should be noted that future scenarios describe present futures rather than future presents. Even though this strategy paper will focus on the year 2030, it includes projections all the way to 2050. Only a longer range of observation allows us to conceive of groundbreaking, disruptive innovations that reinvent the Free State of Saxony under the umbrella of sustainability.

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[8] Innovations don't exist in a vacuum but are linked to existing technical and social structures, which means that adaptability may have a more powerful impact on decision-making than efficiency.

[9] In economics, lock-in effects materialize when costs associated with a change or other barriers make it more difficult for the change to occur in the first place.

[10] Scenario planning is carried out in six steps under DIN SPEC 35811 (DIN German Institute for Standardization 2014).

Using a scenario transfer process, the scenarios developed present lessons for today about sustainability issues in need of decisions. We should emphasize here that these scenarios represent possible future outcomes, which may vary for different industries.

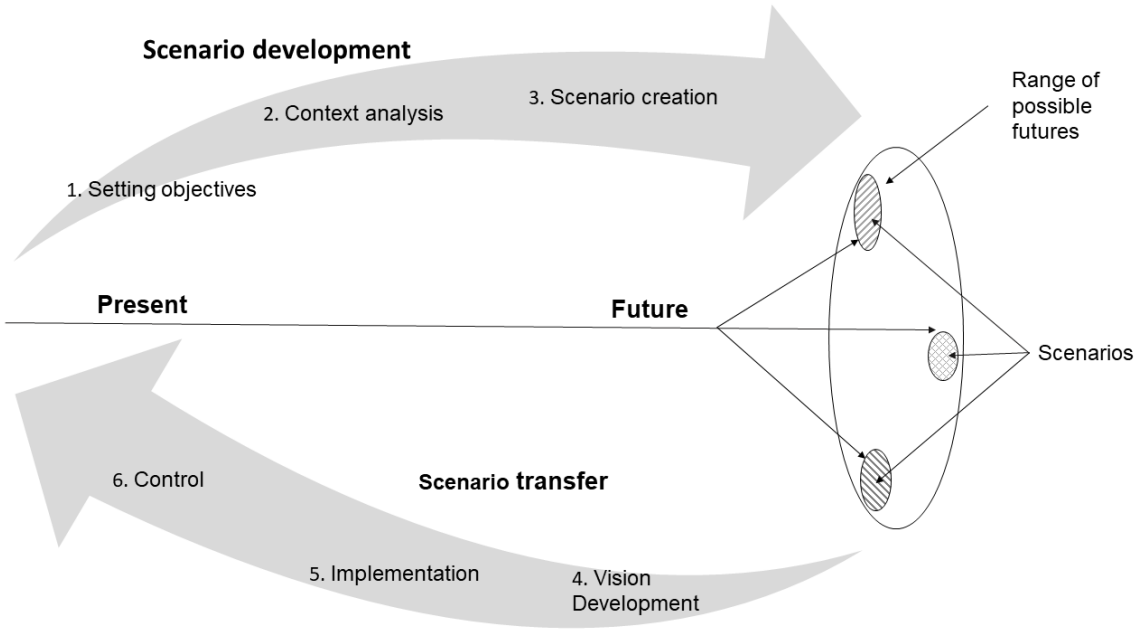


Fig. 2: Six steps of scenario planning (Source: DIN SPEC 35811: 2014-08)

The objective of this strategy paper is to analyze the opportunities and challenges of sustainability for the industry of the future in the Free State of Saxony. Starting points of this analysis are the coalition agreement (CDU State Association Saxony and SPD State Association Saxony 2014) and the sustainability strategy of the Free State of Saxony (SMUL 2013). All findings will be analyzed at the Industry Of The Future Strategy Workshop at the Ministry of Economics, Labor and Transport (SMWA)[11] of the Free State of Saxony.

As part of the *context analysis*, we have examined the general conditions and evaluated the current status using the method of content analysis: As a first step, essential, relevant and already developed documents will be presented: (Sustainability Strategy of the Free State of Saxony (SMUL 2013), Saxon Sustainability Report 2016 (SMUL 2016) as well as documents cited there (such as the Raw Materials Strategy, the Alliance of Skilled Workers[12]) along with the SWOT[13]analysis of the Industry of the Future Strategy Workshop. These sources are analyzed with regard to their relevance for sustainability statements. The coding to be chosen for this is determined using the method of the Invisible College (Cooper 1982). Specifically, the business professors among the PRISMA members, Prof. Dr. Edeltraud Günther, Prof. Dr. Thomas Günther and Prof. Dr.

[11] Learn more at http://www.industrie.sachsen.de/strategiewerkstatt.html.

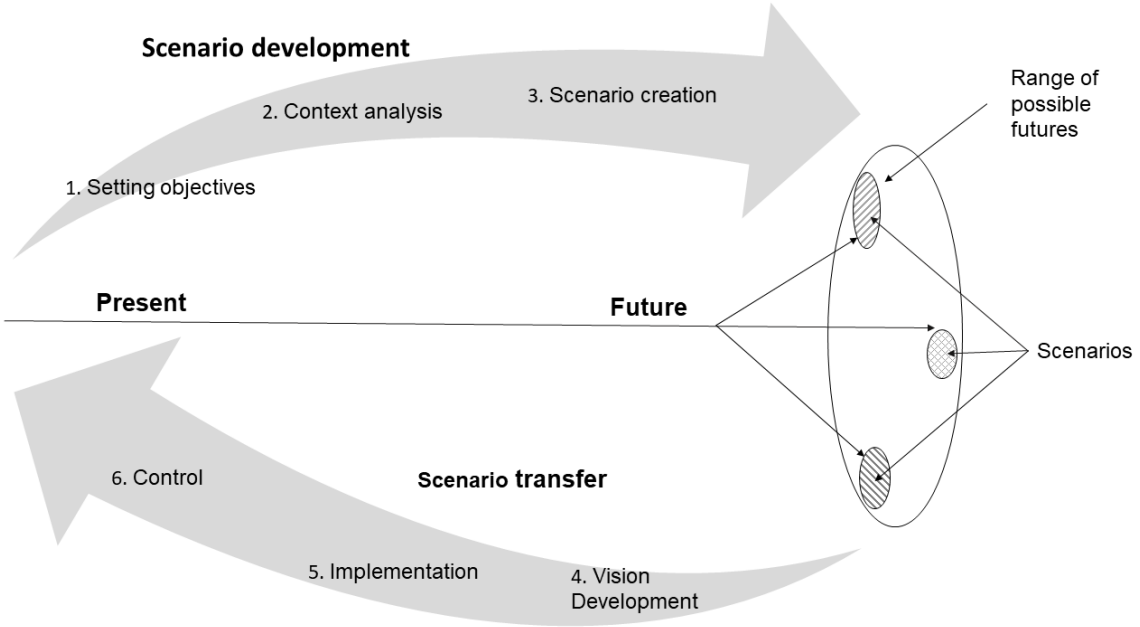
[12] Learn more at http://www.arbeit.sachsen.de/11623.html

[13] The SWOT analysis is used for strategy development and includes an analysis of the current status. The English acronym stands for Strengths, Weaknesses, Opportunities and Threats.

Dominik Möst, have been tasked with identifying the relevant topics based on global megatrends (Bundesverband der Deutschen Industrie 2016; European Environment Agency 2015)) and within the context of analyses they conducted over many years for Saxon industry. These codes are assigned to the three dimensions of sustainability (economic, ecological and social). Ongoing review and comparison with the structural pillars of the sustainability strategy of the Free State of Saxony ensures compatibility. Subsequently, the documents are subjected to a content analysis (Krippendorff 2009).[14]
Possible *scenarios* are created, following the setting of objectives and the context analysis. To this end, the main drivers are identified revealing two development paths *(global orientation vs. local orientation and product orientation vs. function orientation)* as essential counterparts that balance each other out. Tied to this, four scenarios for the industry of the future in the Free State of Saxony are developed. They support companies, policymakers and civil society in an effort to reinvent the State of Saxony in a sustainable fashion.
The scenario transfer is based on these possible future visions. Within the scope of so-called vision development, development options are presented for individual industries. These are designed to stimulate rather than end discussion of creative innovation processes.
In addition, specific recommendations for action will be presented. To monitor ongoing performance on objectives, an instrument of sustainability diagnostics is proposed.

4 Scenario planning

The following section will walk you through the six steps of scenario planning (see



[14] The content analysis was performed and documented manually with the qualitative data analysis software MAXQDA.

Fig. 2).

4.1 Setting of objectives

Scenario planning contributes to rethinking the industry of the future in the Free State of Saxony against the plethora of opportunities and challenges of sustainability. *Reinvent Saxony!* is the vision embraced in this strategy paper. The idea is to plan ahead by one generation – as far as the year 2050 - to conceive of groundbreaking, disruptive innovations. In the scenario transfer, the year 2030 has been selected as a reference point (see Fig. 3). This ensures the capacity to pick up where the Industry of the Future Strategy Workshop that operates on same time frame left off. With *"Industry in Saxony today"* as a starting point, *"Economic activity in Saxony"* in the manufacturing industry and their support services (e.g. logistics, information technologies) will be examined on an expanded time horizon. This is the only way to harness development potential in a broad fashion.

A comprehensive, long-term view of "Life in Saxony", which links all priorities of the sustainability strategy with an extended outlook, is required in order to draw valuable conclusions on economic activity in the Free State of Saxony in 2030. While the success of Saxon industry remains the main concern, the location's appeal, quality of life and employee qualifications are important parameters for future-oriented economic development. The Free State of Saxony ensures a healthy balance between humans, the environment and the economy.

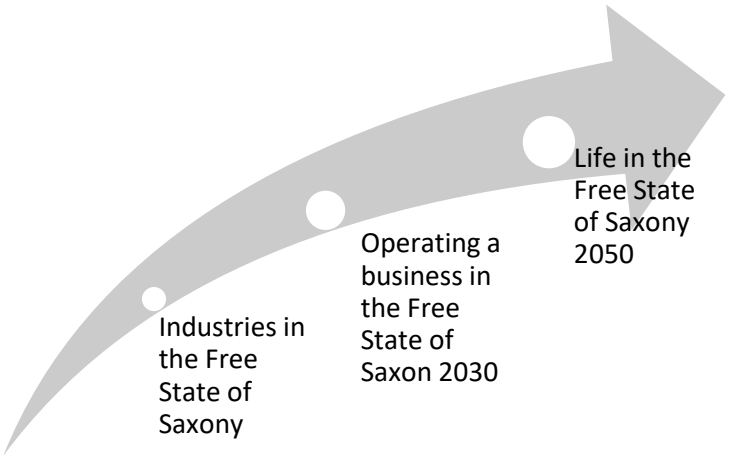


Fig. 3: Scenario perspectives of the strategy paper (source: own presentation)

4.2 Context analysis

Within the scope of the context analysis, we identify and map out the most important areas impacting the field of investigation. While the SWOT analysis within the Industry Of The Future Strategy Workshop primarily views the Free State of Saxony through the lens of the business location, the studies on megatrends (see 4.2.3), which remain part of

the study, specifically include global shifts that the Free State of Saxony, as an export-oriented state, must be prepared for.

4.2.1 SWOT analysis for Saxony

The already available general SWOT analysis of the Industry of the Future Strategy Workshop (Fig. 4) for the Free State of Saxony is discussed separately below from a sustainability perspective.

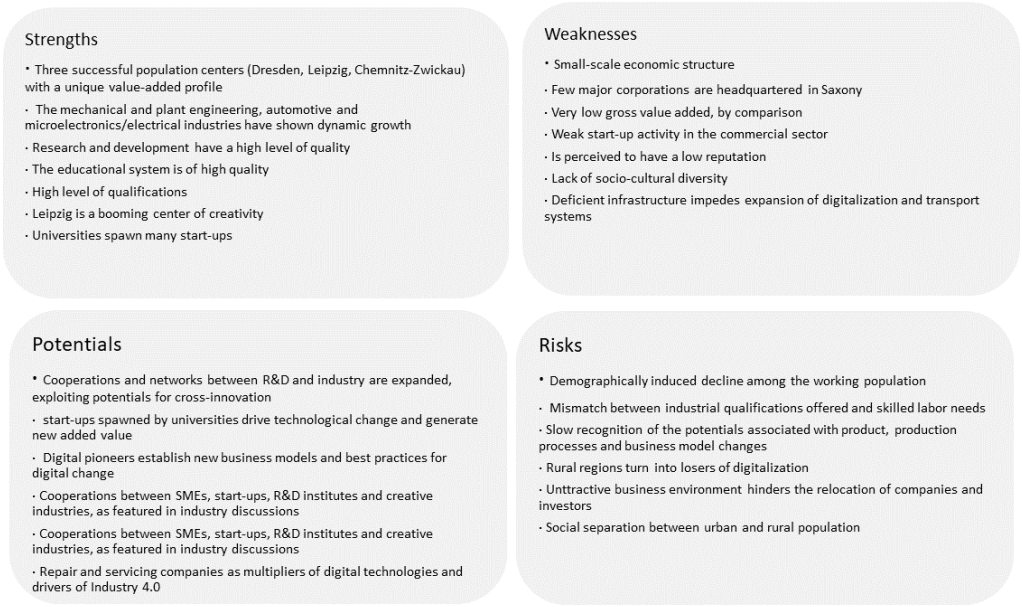


Fig. 4: Presentation of the strengths, weaknesses, risks and potentials of Saxony's industrial landscape with a view to future development (Strategy Workshop Industry - the Future 2016, p. 52)

4.2.2 Evaluation of the SWOT analysis with regard to sustainable development

The smaller scale of Saxony’s economic structure may put the Free State business venue at a disadvantage when it comes to economic sustainability (VDI/VDE Innovation + Technology. Industry Of The Future Strategy Workshop (StrategieWerkstatt Industrie der Zukunft) (ed.) 2016, p. 16, based on data compiled by Statistical Office of the Free State of Saxony and our own data). There is a dearth of large companies and no DAX group is headquartered in Saxony or in another eastern state. Only 0.1 % of companies registered in Saxony are large companies (national average 0.4 %) and in 2013 the share of SMEs in total turnover in Saxony was 67.1 %. What’s more, the majority of SMEs in Saxony are very small and the value companies added to the economy is below average.

On the one hand, this suggests that the region lacks the critical mass to develop ecological or social innovations with vigor. On the other hand, the broad range of small-scale companies makes for a strength and stability that lessens dependence on large corporations such as Siemens for the Leipzig and Görlitz sites or Bombardier for Görlitz.

Moreover, the growing digitalization and the addition of digitized services to industrial products makes the size of local companies less relevant while allowing smaller companies to find a niche for their innovative ideas and develop new business fields.
The Free State of Saxony, however, has a need to provide an appropriate educational infrastructure along with targeted incentives to *larger industrial SMEs,* for example in R&D, when it comes to location decisions or cooperations with universities. The share of value added from design, development, consulting, maintenance, repair and disposal in contrast to pure manufacturing or final assembly must be expanded. This way, industrial value output can be increased and jobs can be created in a resource-friendly manner.
In an effort to inject life into relatively weak *start-up dynamics* in the commercial sector, Sustainable Entrepreneurial Ecosystems[15] should receive targeted incentives through application-oriented research in order to develop new business models to be incorporated into successful start-ups. In doing so, the focus would not only be on economic benefit, but also on business models that put environmental and social concerns front and center (e.g. vision of a Smart City of Dresden[16]). Take, for instance, electric mobility in the Free State of Saxony, which brings together car manufacturers such as VW, BMW or Daimler, transport researchers, e.g., at the Technische Universität Dresden or the Fraunhofer Institute for Transportation and Infrastructure Systems, and the Electric Mobility[17] showcase project).
The Free State of Saxony has the potential to develop existing *strengths*. The strategy pursued after the reunification of Germany, the promotion of *groundbreaking projects* as the core for technological clusters, has been largely successful. These groundbreakers must be supported by targeted efforts to draw medium-sized companies to the Free State (instead of subsidizing multinational corporations) and to promote their growth (through state guarantees, loans from Saxon credit institutions, etc.). Since SMEs and family-owned companies tend to be more loyal to their location and the region anyway, steps like these would reduce external dependencies and put the industry in an economically more sustainable position.
The Free State of Saxony boasts three successful industrial regions - Dresden, Leipzig and Zwickau-Chemnitz - and a significant dynamic development in the clusters of *mechanical and plant engineering, automotive and electronics.* Especially the automotive industry and its suppliers, but also the mechanical engineering industry will undergo lasting changes in the next ten years, raising the industry's need to discuss topics that

[15] The term sustainable entrepreneurial ecosystem, more commonly used in English-speaking countries, describes a group of interdependent actors who make successful sustainable entrepreneurship possible.

[16] Further information on the Smart City Dresden vision is available at http://www.dresden.de/de/wirtschaft/wirtschaftsstandort/projekte-kooperationen/smartcity/matchup.php

[17] Further information on the Federal Government's Electromobility Initiative is available at http://schaufenster-elektromobili-taet.org/de/content/ueber_das_programm/foerderung_schaufensterprogramm/foerderung_schaufensterprogramm_1.html

address future growth.[18] For example, the automotive industry has been moving away from the combustion engine (e.g. focus on electromobility at Volkswagen Zwickau or the growing expansion of electronic systems in cars). As a result, entire component groups and associated jobs are no longer required. Car users are also shifting their preferences from ownership to car sharing. Mechanical engineering, too, is changing with the influx of digitalization, automation and new production technologies such as 3D printing.

This irreversible transformation offers starting points for the development of new ecological and social use concepts. On the one hand, new business ideas develop from sharing products instead of owning them: the so-called sharing economy, e.g. TeilAuto,[19] sz-bike[20] or TiMMi Transport[21]; on the other hand, consumer benefits are provided by evaluating customer usage data (Big Data), e.g. see how ekoio smart telematics[22] analyses and optimizes customer fuel consumption).

Regionally, steps must be taken to ensure that the three *economic hot zones* do not "overheat" (due to a lack of engineers and skilled technical workers) and that their surrounding and rural areas do not fall victim to the pull of the big cities. As will be explained later, more consideration must be given to questions on how medium-sized centers or rural areas can be served better.

The Free State of Saxony boasts *high-performing universities with strong research pedigrees* including three technical universities, several technical schools of applied sciences and an education system whose reputation extends beyond the borders of the Free State of Saxony. Based on these fundamentals, cooperative relationships between corporate R&D managers and researchers at universities can be expanded through targeted funding, and spin-offs from universities may spawn new products and services that can be supported in targeted ways. This requires both sides to seek closer cooperation and to work more strongly across disciplines in order to strengthen not only product and service technology but also ecological and social sustainability. Start-ups from communities affiliated with the university provide a significant potential for the creation of companies dedicated to technical innovation and add more value to the Free State economy. The focus should be on increasing the value-added share through less tangible (i.e. reduced consumption of raw materials and fewer intermediate products in manufacturing) and more intangible benefit components for customers. For example, enhanced engineering generates higher value or improved use, e.g., by evaluating usage data for consumer goods through predictive maintenance, remote maintenance or customer-focused advisory services for better capacity utilization). The strong position of

[18] The innovation strategy of the Free State of Saxony (SMWA 2013) identified micro- and nanoelectronics, organic electronics, nanotechnology, new materials and advanced production technologies as key technologies.

[19] Learn more at https://www.teilauto.net/

[20] Learn more at http://www.sz-bike.de/de/dresden/l

[21] Learn more at http://www.timmitransport.de/index.html

[22] Learn more at https://www.ekoio.com/de/

the IT industry in the greater Dresden area can be expanded further. Digital pioneers such as 3m5[23] and T-Systems Multimedia Solutions[24] that also act in an environmentally friendly and socially responsible manner can also be groomed in this area.

Due to structural changes after reunification, the Free State of Saxony also boasts a highly sophisticated and competitive *health care sector* that is competitive at least on a national level. The reduction of bed capacities and restructuring has rendered both the hospital and outpatient sectors much more efficient than sectors in other German states but has also contributed to staffing shortages in rural areas. To close the gap, experts recommend the promotion of digitalization in health care to expand access to telemedicine products. Since Saxony by necessity also holds a pioneering role in demographic change, it would only be prudent to expand telemedicine applications for older people and in rural areas. Research projects[25] exploring this complex of issues have already been initiated at universities. In addition, biomedicine and biotechnology have received strong financial support in recent years (e.g. the Biotechnology Center (BI-OTEC), Center for Regenerative Therapies (CRTD) at the Technische Universität Dresden, etc.). Here, another promising field for industrial products and services can be built up in addition to electronics and automotive/mechanical engineering. Know-how must not only be developed in Saxony, but also used in Saxon companies or spin-offs, thus contributing to the sustainable development of our state.

The Free State of Saxony is undergoing considerable *demographic change*. Low-birth cohorts and emigration due to the lack of job prospects after reunification have led to a decline and aging of the working population. At the same time, *urbanization* has become an apparent trend. The working population is flocking to large cities with their rich cultural and leisure offerings even though people may work in medium-sized population centers or in the countryside. While large cities, especially Leipzig and Dresden, are experiencing population growth, the population in medium-sized centers (e.g. Pirna, Annaberg, Görlitz) and in the countryside is shrinking. As a result, the Free State of Saxony will have to deal with a decline in the working-age population, which will be particularly noticeable among skilled workers with already low unemployment. At the same time, the job training programs being offered don’t match the current need for industry qualifications and skilled workers. For example, there is a lack of skilled workers in the fields of mathematics, information science, the natural sciences and technology (MINT) at both skilled worker and engineering level. An increased and targeted cooperation between companies and universities, vocational schools and technical

[23] Learn more at https://www.3m5.de/

[24] Learn more at https://www.t-systems-mms.com/

[25] For more information on exemplary research projects, go to:
- Telemedizinische Netzwerk Psychotraumatologie Sachsen (Tele-NePS) at https://tu-dresden.de/bu/wirtschaft/sysent/forschung/forschungsthemen/gesundheitswirtschaft/telemedizin/tele-neps,
- Innovative Versorgungsmodelle durch Digitalisierung (Care4Saxony) at http://care4saxony.de und

CCS Telehealth Ostsachsen at https://tu-dresden.de/bu/wirtschaft/sysent/forschung/forschungsthemen/gesundheitswirtschaft/telemedizin/ccs-telehealth

colleges, as well as targeted planning and coordination of university training capacities by the Saxon State Ministry of Science and Art (SMWK) together with SMWA and the Saxon State Ministry of Culture (SMK), would be helpful in this regard.
Furthermore, under the current conditions, there is a real risk that segments of the population will perceive *rural areas* as "losers of digitalization" due to a lack of broadband expansion, poor mobile phone accessibility and reduction of transport, health and cultural infrastructure. Therefore, the quality of the infrastructure in these areas must be improved in rural areas as well. This shows that, next to economic criteria, social issues have gained importance for both companies and the population at large. Furthermore, it is still possible to preserve much of the old growth landscape through groundbreaking projects and cross-border projects with the Czech Republic and Poland and to strengthen its appeal as an essential factor that draws job seekers to the region. This way, ecological assets can be promoted deliberately as a factor for relocation (e.g., attractive local recreation and vacation areas; living where others spend their vacation). This is the only way the Free State of Saxony can compete with regions in Germany and around world when it comes to attracting new companies. Since few major corporate relocations have materialized in recent years, a shift should be made towards the promotion of local industry, which is dominated by SMEs. To this end, the following steps should be pursued: broader support of SMEs through stronger ties between schools or universities and companies, both in terms of professional exchanges, fostering of talent, development of management skills, financial support for modernization and expansion, expansion of the digital infrastructure also in rural areas, encouragement of small businesses to grow and expand, support for succession arrangements, etc., i.e. offers in the low-threshold area, appear to make sense in this context.
At present, there is a *growing social disparity between urban and rural population*, which has also been borne out by different growth and birth rates. On the one hand, this trend can be addressed in a targeted manner by utilizing rural areas for local recreation and as a reservoir for the preservation of various species. On the other hand, rural infrastructure can be improved by developing smaller towns as residential areas for population centers and by raising their appeal among commuters. Templates for this can be found in various European regions. One example is the outstretched fingers of Copenhagen's housing developments after World War II. Suburbs spread out like fingers on a hand were connected to the city by train while the land in between was reserved for green spaces and local recreation. Suburbanization and the resulting increased consumption of land for living space and transport needs to be counteracted by the planning of transport and housing divisions.
From a sustainability viewpoint, there is an urgent need to adopt a different position on industrial reorientation. To promote ecological sustainability, the conservation of environmental resources must be front and center. As a result, "new" value creation concepts and business model developments should focus on *non-material product and service components.*

The EU action plan for the recycling industry (European Commission 2015) contains a wide range of suggestions for using the value of products, materials and resources for as long as possible while generating as little waste as possible. For example, the service life of products can be extended by repair and maintenance work that maintains or even increases their value. Functional multiple use, e.g., via offers from the sharing economy may increase usage. An often quoted example is the tongue-in-cheek relabeling of the word for car from "Fahrzeug" to "Stehzeug", (literally, “driving apparatus” to “standing apparatus”), conceived on the notion that cars stand still most of the time and usually do not run at full capacity. From an operational standpoint, machines with low utilization provide an incentive for sharing.[26]
Thinking in terms of functions or customer benefit can spark innovations such as upcycling as a trend in the fashion industry. All these options can increase the added value through intangible services. Along with this reorientation, basic rules of social sustainability should also be considered. Innovative models for shaping the workplace are considerate of the welfare of individual employees when suppliers from Eastern Europe or Asia implement humane working conditions. The Free State of Saxony should strive to shed the reputation of a low-wage hub and replace conditions that are inferior to other European countries with conditions that are more favorable towards earning a reputation for high-quality – and - sustainable value.

4.2.3 Megatrends

Megatrends are long-term developments that have already begun to shape society and have an impact on the future. Analyses of global megatrends (Bundesverband der Deutschen Industrie 2016; European Environment Agency 2015) suggest the following developments for the three dimensions of sustainability:

- For the *ecological dimension* of sustainability, rapid transformation in energy and other resources, but also climate change and rising environmental pollution is to be expected. For Saxony, lignite-based value creation, in particular electricity generation, has thus far been of great relevance, although the megatrend of decarbonization has counteracted it. In light of the growing scarcity of resources, resource efficiency is gaining in importance. Likewise, the increasing loss of biodiversity poses new challenges. For instance, the German Federal Ministry of Food and Agriculture (BMEL) estimates the benefits of bees at around 2 billion euros. Throughout the EU, the bee is classified as the third most important farm animal after cattle and pigs.[27]
- As for the *social dimension* of sustainability, the increase in mental illnesses (e.g. stress, burnout or depression), increasing urbanization, migration and global population growth, as well as individualization and polarization should be

[26] For more information on „Das Auto: Stehzeug für Solisten“, visit: http://www.mobilogisch.de/41-ml/artikel/238-auto-alltagsmobilitaet.html

[27] Learn more at https://www.landwirtschaft.sachsen.de/landwirtschaft/26227.htm

considered. Urbanization is reflected in the population growth of centers like Leipzig and Dresden while the demographic development of other regions shows that they are shrinking.

- From an economic viewpoint, the first thing to be noted is that competition has gone global. At the same time, new consumer patterns are emerging such as more customized products in many areas, including medicine. Another megatrend is digitalization or the knowledge-based economy. This development spawns new business models such as the sharing economy (e.g. Konglomerat e.V.[28]), but also new working models (IT companies offer innovative work hours and corporate culture models employ specialists from Saxony and provide programming for clients from outside the region). In addition to the work environment, digitization is also changing work processes: Machines communicate with each other and can transfer data for sustainability assessments.[29] Furthermore, new mobility patterns are emerging and mobility is on the rise.

4.3 Scenario creation

For scenario creation purposes, the key factors that will significantly determine the future are derived from the environment analysis.

For industrial companies in the Free State of Saxony, two dimensions emerge from the analyses as dominant:

- One option is for industrial companies to select - quite specifically for each business unit - a global or/and regional orientation.
- Another option is for industrial companies to shift their focus towards a range of products (product orientation) or/and adapt their range towards customer needs, highlighting the functions of product/service bundles (function orientation).

If we break down the possible futures on the basis of these two dimensions, four possible scenarios emerge: "*Groundbreaking projects", "Digital engineering*", *"From the region, for the region"* and "*Vertical integration through industry support services"* (see Fig. 5).

[28] Learn more at http://fablabdd.de und https://konglomerat.org/rosenwerk.html

[29] One example of how digitalization can be harnessed for sustainable development ist he business idea of ekoio smart telematics

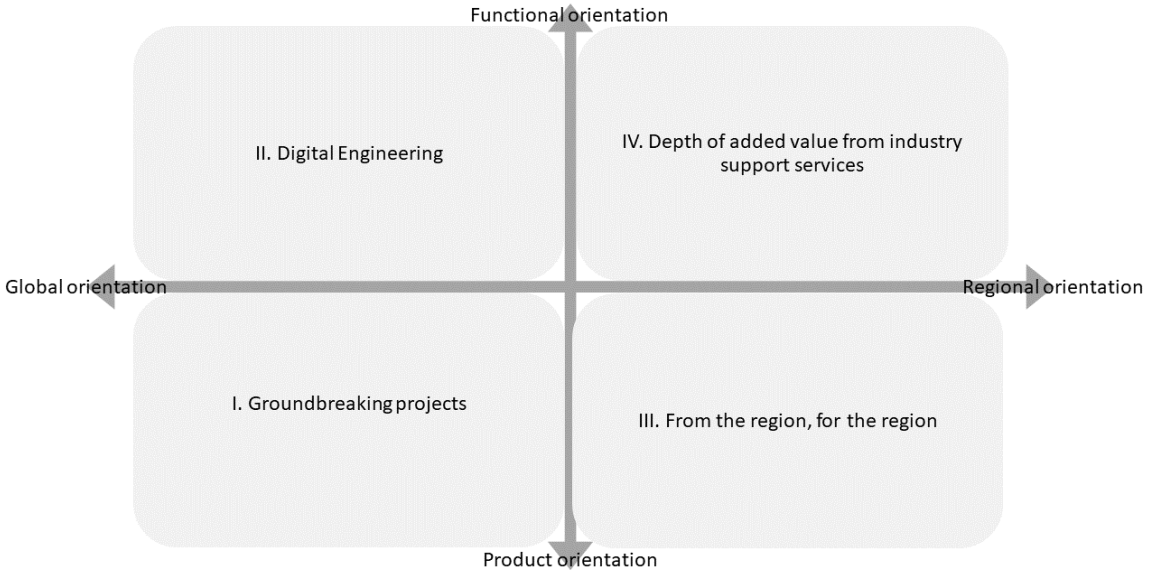


Fig. 5: Possible futures for Saxon industry (Source: own presentation)

Industrial areas centered around large companies function as *"groundbreaking projects"*. As a beacon to other companies, firms such as Autounion before World War II and Silicon Saxony after reunification contributed significantly to Saxony's economic upswing. Even today, Saxon companies have worldwide appeal. Europe's largest microelectronics venue is located in the region between Freiberg, Chemnitz and Dresden.[30] In order to use the sustainability potential of the Saxon industry, the successful model of the Saxon auto manufacturing sites or Silicon Saxony should be adopted and developed further within the meaning of a sustainable entrepreneurial ecosystem.

"Digital engineering" as a possible future of the Saxon industry focuses on providing solutions and functions for customers through intelligent product and usage concepts (e.g. self-controlling or communicating machines and systems, 3D printing of spare parts, targeted evaluation of usage data, as in predictive maintenance, analysis of customer or machine data etc.). Digital solutions also make it possible to detangle supply and demand spatially, thereby facilitating the acquisition of global customers. Digitized services can also be provided from home where an efficient digital infrastructure is available. They may be able to break the impasse between work and home in favor of rural areas. It should be noted, however, that this requires an appropriate build-up of the digital infrastructure.

[30] In Silicon Saxony, companies and research institutions research, develop and produce modern information and communication technology. This entrepreneurial ecosystem combines the fields of micro and nanoelectronics, telecommunications technology, photovoltaics, IT and information technology, energy-efficient systems, smart systems and networked sensor technology as well as organic and printed electronics. Learn more at https://www.silicon-saxony.de/der-standort

Sustainability gains can result from targeted industrial production *"from the region for the region"* (e.g. in the food industry), as this would eliminate long transport routes and other ecological burdens such as production in Eastern Europe or Asia at low environmental standards. Moreover, familiar higher social standards can be guaranteed at the regional level. In contrast to global supply chains, which may be characterized by cultural and legal differences that are difficult to control, a consumer proximity strategy also makes personal identification with the products much more likely.
If a regional focus can be matched with a functional focus, opportunities for sustainability emerge. The *"depth of added value through industry support services"* is increased through local repairs of machines instead of disposal, urban mining[31] (such as vouchers for the disposal of mobile phones and electrical appliances in recycling programs[32]) instead of raw material extraction in the Third World, extended local use of materials through recycling instead of continuous flow management). All these efforts facilitate dematerialized growth, or growth with reduced resource consumption.

4.4 Vision Development

For all four possible futures, numerous examples can be found in the Free State of Saxony (see Fig. 6), which show how Saxon companies are already taking advantage of the opportunities of sustainability and preparing for the challenges.

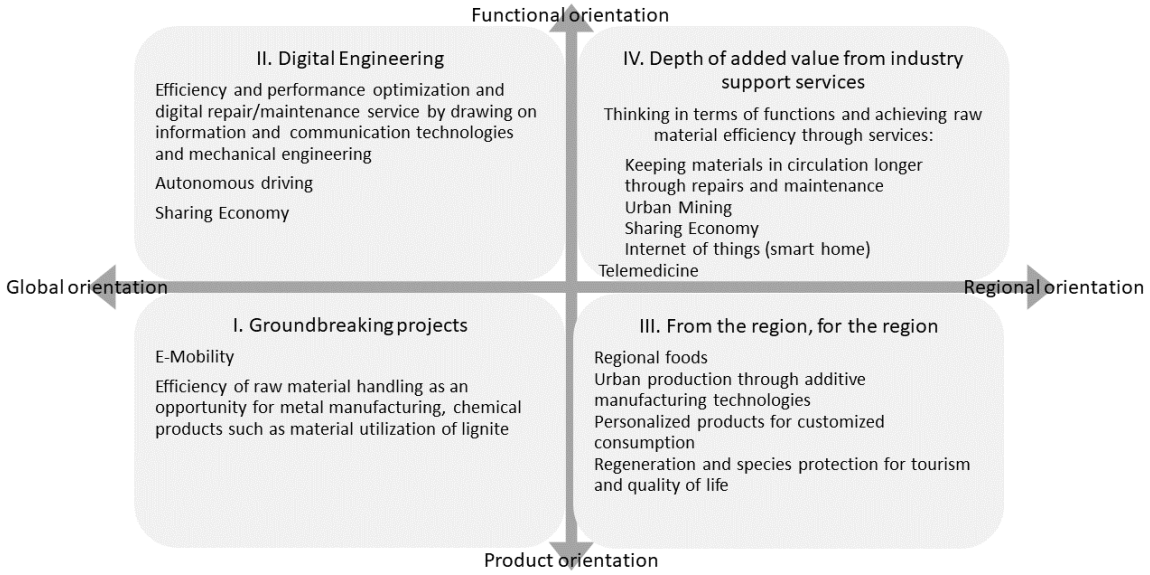


Fig. 6: Possible futures for Saxon industry with examples (Source: own presentation)

[31] Urban Mining can be translated as mining in urban areas, but is not limited to urban areas. It involves the identification of anthropogenic deposits, quantification, profitability calculation and recovery of secondary raw materials.

[32] Learn more at https://www.binee.com/

Individual fields highlight different strategies to be pursued by Saxon industry, which can be pursued individually or in bundles. In order to underscore the appellative motto of this strategy paper ("Reinventing Saxony"), the suggested courses of action are formulated as theses:

I. Groundbreaking projects

Thesis 1: Increases in resource and energy efficiency in production processes lessen the burden on the environment and yield cost savings at the same time.

Fig. 7: Thesis path 1 (Source: own presentation)

Thesis 2: A proactive approach to the challenges of sustainability leads to innovative product development that may provide access to new markets.

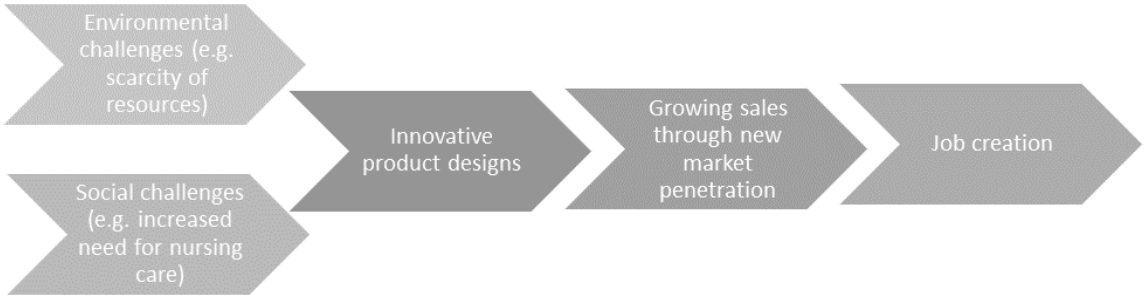


Fig. 8: Thesis path 2 (Source: own presentation)

II. Digital Engineering

Thesis 3: Digitization allows for a spatial separation of employees and employers.

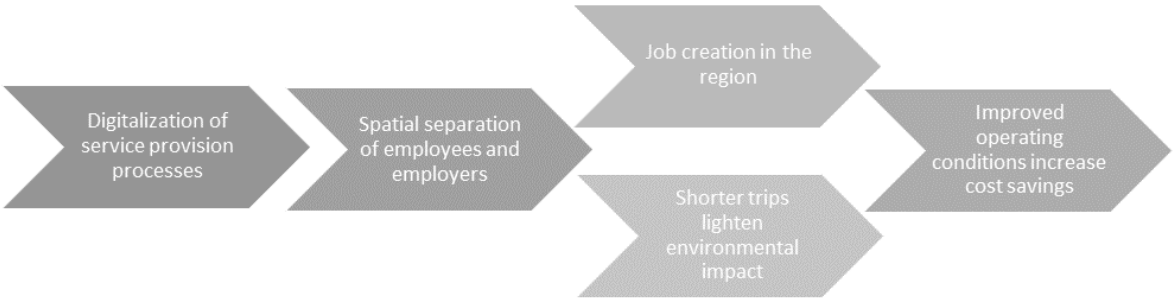


Fig. 9: Thesis path 3 (Source: own presentation)

Thesis 4: Digitization facilitates worldwide cooperation regardless of location.

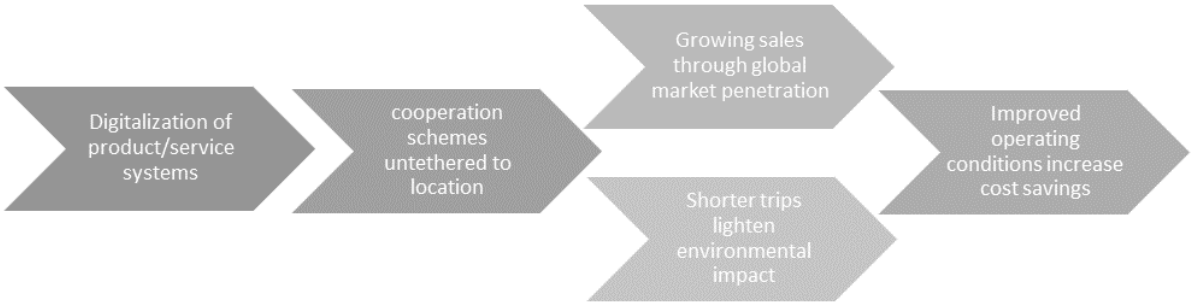


Fig. 10: Thesis path 4 (Source: own presentation)

III. From the region, for the region

Thesis 5: Appreciation for regionally manufactured products increases the location's appeal.

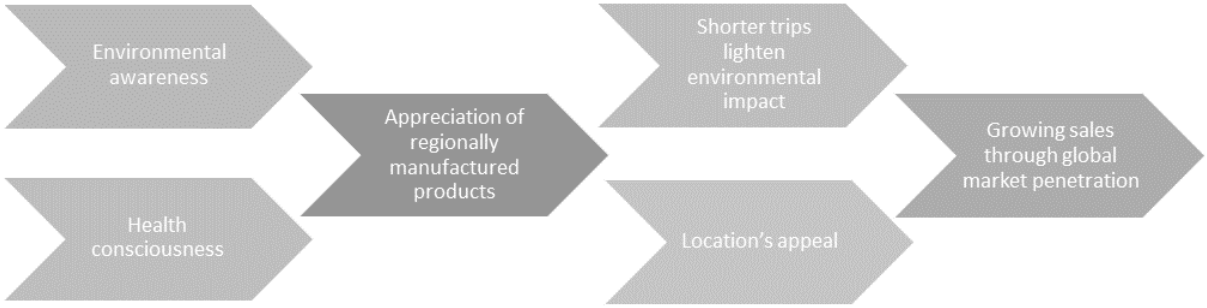


Fig. 11: Thesis path 5 (Source: own presentation)

Thesis 6: The demand for individualized consumption requires a unique selling proposition in order to create customer proximity.

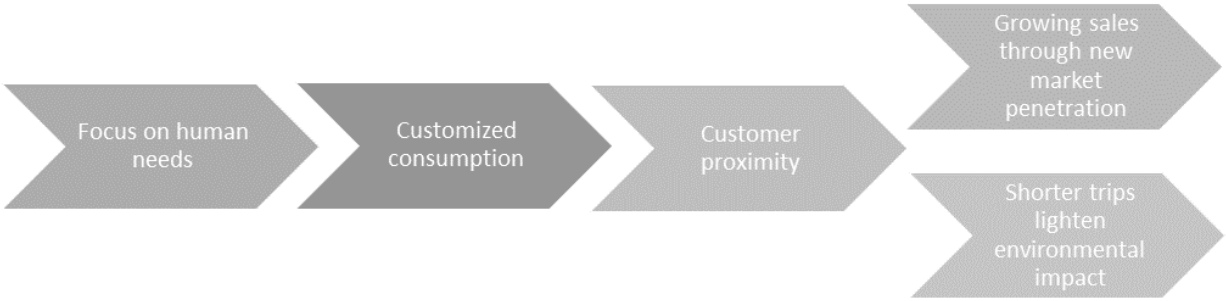


Fig. 12: Thesis path 6 (Source: own presentation)

IV. Depth of value added through industry support services

Thesis 7: Service offers as part of a Sharing Economy make possible economic success without additional resource consumption.

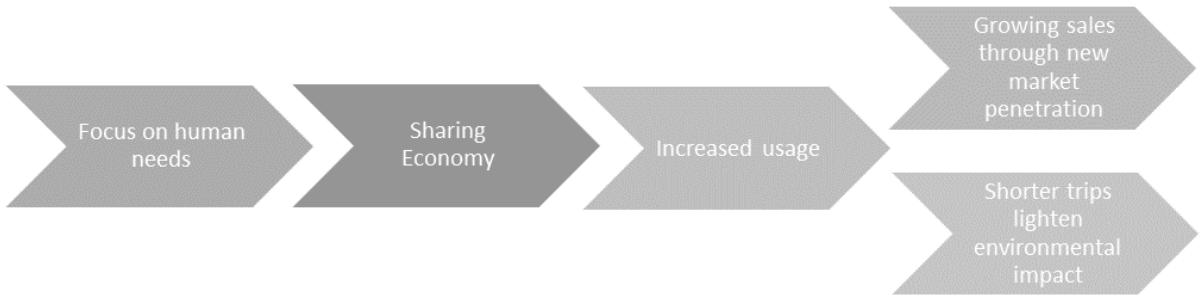


Fig. 13: Thesis path 7 (Source: own presentation)

Thesis 8: A circular economy extends useful lives and uses resources more effectively and efficiently.

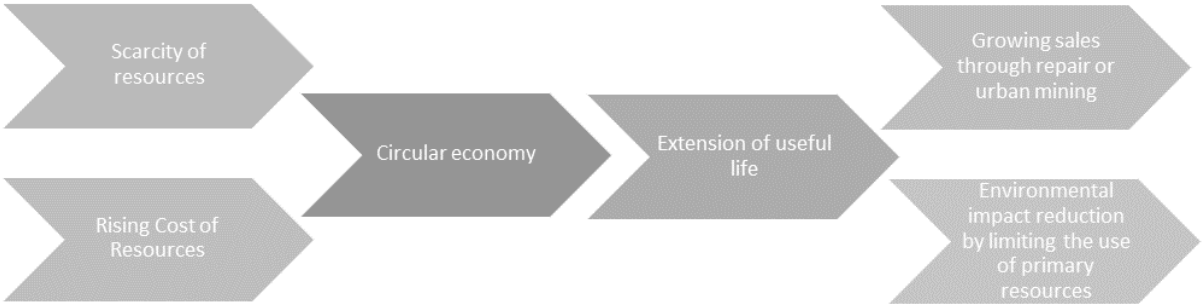


Fig. 14: Thesis path 8 (Source: own presentation)

Further build-up of the existing infrastructure is the basis for all four developed futures, and by extension, the increased sustainability of Saxon industry.

Thesis 9: An attractive public transport system connects jobs, residential and recreational areas.
Thesis 10: The digital infrastructure in cities and rural areas is globally competitive.
Thesis 11: The education system is designed in such a way that employees can acquire necessary qualifications and continue to educate themselves.
Thesis 12: The health care system guarantees care for employees and their children as well as for parents in need of care.

4.5 Implementation – stakeholders and recommendations for action

The recommendations for action are structured along the three dimensions of sustainability (see Fig. 15):
- Ecology: Energy supply and climate change,
- Society: education and health,
- Economy: entrepreneurship and business start-ups, and
- as a fundamental requirement: infrastructure.

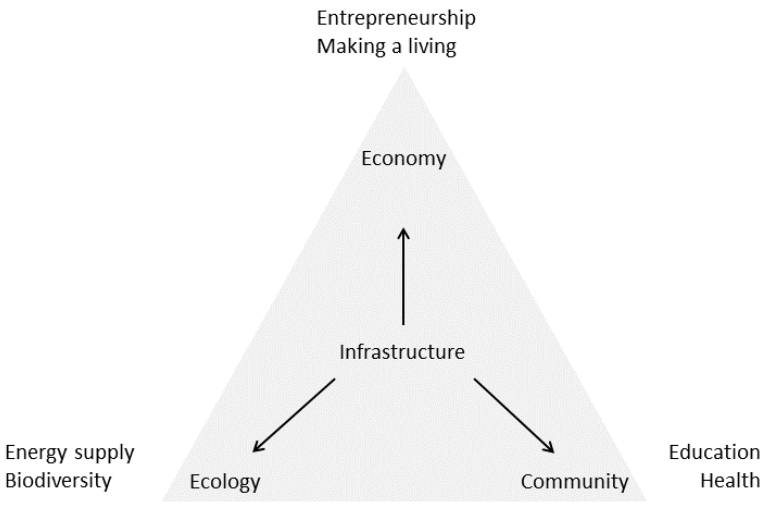


Fig. 15: Action fields incorporated into the sustainability triangle (Source: own presentation)

4.5.1 Action field of ecology: Energy supply and climate change

Saxony's electricity supply with a gross electricity generation of approx. 42 TWh is characterized by the use of domestic lignite, which contributes approx. 80% of all electricity generated in the Free State of Saxony. Slightly more than half of that is also consumed in the Free State, leaving a large volume of electricity for export. Due to Germany's climate protection mandates, a phase-out of lignite as a CO2-intensive energy source is inevitable in the medium to long term, affecting approx. 10,000 jobs in eastern Germany (Wörten et al. 2017) and the Free State of Saxony. Although the time line for this to occur is impossible to predict, the impending structural change and comprehensive planning should be initiated immediately given that there have been demands among lawmakers for a faster phase-out of lignite. Since new jobs are created much more slowly than old ones are lost, especially in the case of a rapid exit, the transformation should be actively managed by state policymakers today so as to provide employees in the lignite industry with options to adapt to gentle structural change. Due to the rural character of the venues, the two scenarios with regional orientation *"Depth of value creation through industry support services"* and *"From the region, for the region"* ought to be actively developed. To this end, the qualification level of workers departing from the declining lignite mining industry needs be analyzed. Targeted relocation of SMEs in need of these skilled workers could strengthen the region and promote structural change.

In addition, the medium to long-term loss of lignite capacity must be addressed. Wind energy, photovoltaics, gas power plants along with digital solutions and a bundling of the electricity, heat and mobility sectors offer an important new play field for the energy system in the Free State of Saxony. Lawmakers should advocate for the expansion of renewable energies, and back-up technologies should be used to ensure that sufficient capacity is available. Since innovative solutions for a demand-oriented, manageable energy supply will be required on the generation, distribution and consumer side, and

since the international pioneering role of the German energy system transformation can also be leveraged, the two scenarios with a global perspective, *"Digital Engineering"* and *"Groundbreaking Projects"* should serve as a template for political decision-making. The company KiWiGrid, a spin-off of the Technische Universität Dresden, is a prime example in the "Digital Engineering" scenario. The company has developed innovative and energy-efficient software solutions on the basis of a secure and scalable platform that guarantees a high level of data protection, thus contributing to an integrated energy system by linking the electricity, heating and mobility sectors.

Climate change (see Fig. 16) will have a variety of impacts on companies in the Free State of Saxony. For example, one direct impact on manufacturing conditions will be the rising number of hot days as well as rising top temperatures, affecting air conditioning of manufacturing facilities and the cooling of cold and deep-freeze warehouses. In addition, radiation has an impact, e.g., on employees in the construction industry. Decreases in the quality of manufactured products or production losses can be caused by extreme weather events (e.g. flooding in Dresden and Görlitz). Not to mention the added physical strain on employees. Extreme weather events such as flooding or drought will have indirect effects on the security of the water and energy supply. The extraction and supply of energy and raw materials will become more difficult due to extreme weather conditions, which may result in production cutbacks. In addition, climate change is likely to result in a structural change in the demand for consumer goods. This will lead to the development of new markets, but may also reduce existing market opportunities.

Time slice	*1961-1990* measurement	*1991-2010* measurement	*2021-2050* models	*2071-2100* models
	Mean value	change	mean change (range)	mean change (range)
Average annual temperature (°C)	**8,3**	**+0,6**	**+1,1** (+0,6 to + 1,4)	**+2,9** (+1,4 to +3,5)
Temperature for summer half-year period (mm, °C, April - September)	**13,9**	**+0,8**	**+0 ,9** (+0,5 to +1,3)	**+2,6** (+1,1 to +3,2)
Temperature for winter half-year period (mm, °C, October - March)	**2,6**	**+0,5**	**+1,1** (+0,7 to +1,5)	**+3,2** (+1,7 to +3,6)
Number of summer days (maximum temperature 25°C and above)	**31,4**	**+9,1**	**+ 11 ,3** (+6,3 to +20,0)	**+30,8** (+13,1 to +48,7)
Number of hot days (maximum temperature 30°C and above)	**5,4**	**+3,4**	**+3,9** (+1,8 to +9,1)	**+13,5** (+3,5 to +24,6)
Number of tropical nights (minimum temperature 20°C and above)	**0,7**	**+0,5**	**+ 1,1** (+0,2 to +2,0)	**+4,4** (+0,5 to +9,0)
Number of icy days (maximum temperature below 0°C)	**32,5**	**-5,6**	**-8 ,6** (-13,2 to -4,7)	**-19,1** (-26,1 to -12,9)
Number of frost days (minimum temperature below 0°C)	**91,5**	**-0,3**	**-17,3** (-23,5 to -11,7)	**-44,5** (-53,4 to -26,7)
Degree-days of heating (K measures heat energy demand during the heating period)	**3882**	**-254**	**-342** (-463 to -181)	**-930** (-1098 to -478)
Degree-days of cooling (K measures AC demand during the summer period)	**41**	**+19**	**+30** (+15 to +60)	**+104** (+31 to + 156)
Average annual precipitation (mm)	**793**	**+45**	**-20** (-77 to + 48)	**-43** (-99 to + 16)
Precipitation summer half-year period (mm, April - September)	**439**	**+17**	**-21** (-54 to +10)	**-52** (-71 to -29)
Precipitation winter half-year period (mm, October - March)	**354**	**+28**	**+0** (-26 to +35)	**+11** (-30 to +49)
Number of dry days in the summer half-year period (precipitation less than 1mm)	**125**	**+1**	**+3** (0 to +7)	**+8** (+0 to + 12)
Days with heavy precipitation in the summer half-year period (precipitation of 20 mm and above)	**3,6**	**+0.5**	**-0,1** (-0,7 to +0,2)	**-0,2** (-0,6 to +0,3)
Potential evaporation (mm, maximum possible evaporation)	**607**	**+34**	**+34** (+8 to +92)	**+71** (+28 to + 124)
Climatic water balance (mm, precipitation minus potent. Evaporation)	**188**	**+13**	**-63** (-180 to +40)	**-120** (-248 to -12)
Radiation (global radiation in KWh / m2)	**1053**	**+33**	**+31** (-17 to + 102)	**+57** (-9 to +135)
Duration of thermal vegetation period (number of days)	**201**	**+7**	**+10** (-1 to +16)	**+41** (+19 to+59)

Fig. 16: Predicted climate changes for the Dresden model region (Bernhofer et al. 2013, p. 3)[33]

Various adaptation strategies can be derived for companies, as shown in the example from the construction industry:

[33] Learn more at www.unternehmen-klimawandel.de.

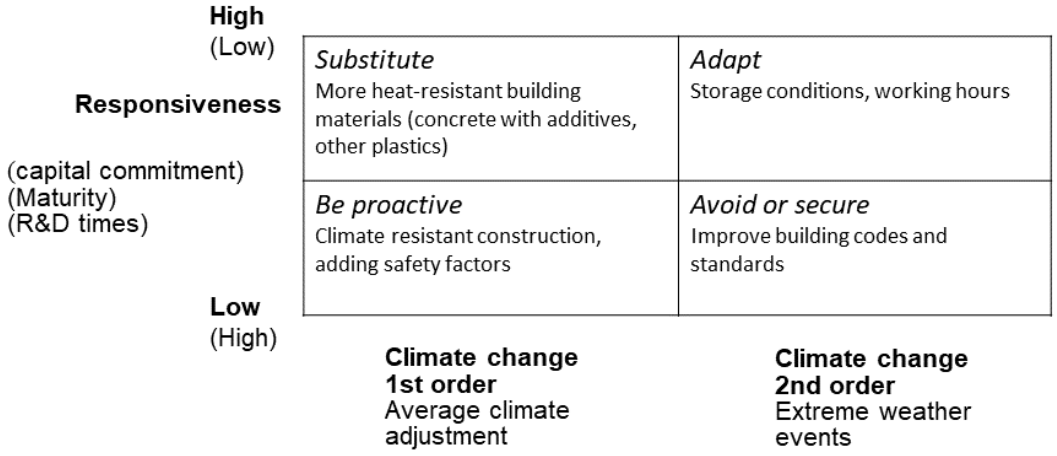


Fig. 17: Construction industry adaptation strategies to combat climate change (Günther et al. 2013, p. 3)

4.5.2 Action field of community: Education and health

Due to the traditionally high quality of the school and university system in Saxony, the education system provides essential support and plays an important role in the further sustainable industrial development in the Free State of Saxony. It is currently under some pressure, particularly due to the shortage of teachers, which will continue in the coming years. To foster economically and socially sustainable development, it must be ensured to a high degree that the training capacities at both technical schools and universities are strategically coordinated between the SMWA, SMK and SMWK. This will ensure that appropriate numbers of skilled workers are available in the next decades, especially in the areas of health/medicine/biotechnology, education/teacher training and in the MINT subjects. What's more, in order to further develop the Free State of Saxony, a deliberate pivot towards the global environment, participation of all and different levels of society as well as openness towards and acceptance of third parties and innovations will also be required. In order to utilize the skills of the state's population as holistically as possible, gender-specific development paths must be considered from early childhood education onwards. The expected digitalization and automation will pose new challenges for all professions; as a result, all employees, both those eligible for support and those in need of support, need to be continually educated by their employers but also by educational institutions. This social dimension of sustainability has the potential to make or break economic sustainable development in the Free State of Saxony.

An understanding of the necessity of economic, ecological and social sustainability combined with an open mind for new ideas will lay the groundwork for founders, managers and specialists to develop new business models for *"digital engineering"*, *"vertical integration through industry support services", "from the region for the region"* or to promote them as customers.

Along with education, the health care system is an action field representing the social dimension of sustainability. Good doctors, medical care and nursing services must be available at all stages of life. This requires both good regional health care within the

meaning of *"from the region, for the region"* and research capacities to further develop preventive and treatment options.
The Heart and Cancer Center at the Technische Universität Dresden is one example of a *groundbreaking project"* in patient care. Other areas attract a lot of research, too, for things like improving diagnosis and therapy. For instance, the fundamental research on stem cells at the Center for Regenerative Therapies (CRTD of the Technische Universität Dresden), the development of genetic surgery in the fight against HIV and hereditary diseases at the Max Planck Institute of Molecular Cell Biology and Genetics, or optimization of photon therapy for cancer treatment at the OncoRay Center of the Technische Universität Dresden should all be considered groundbreaking projects.
The network of general practitioners must be strengthened for basic care *"from the region, for the region"*. By combining outpatient and inpatient as well as interdisciplinary and multidisciplinary services, patients can be treated more holistically and capacities can be used more efficiently, thus improving care in rural areas. Through *"digital engineering"*, further discoveries in telemedicine may improve the provision of specialist doctors in rural areas. In light of the demographic change, senior care must be expanded. At the same time, wages for nursing should be raised, although the hands of the Free State of Saxony are tied by national regulation. The increasing number of both mental and addictive illnesses must also be counteracted with appropriate preventive and therapeutic measures.

4.5.3 Action field of business: entrepreneurship and business start-ups

The industrial clusters in automotive, mechanical and plant engineering, electronics and biotechnology, which have emerged since reunification, as well as the regional clusters in Dresden, Leipzig and Chemnitz/Zwickau, form a valuable critical mass that must be maintained. But they must also be given a stronger ecological and social orientation. Global megatrends require the Free State of Saxony to reconsider some of its stances, as it cannot help being affected by changes such as urbanization, climate change or resource conservation. The previous focus on low-value-added manufacturing must be supplemented by *"Adding depth to value through industry-related services"* in the shape of sophisticated, resource-friendly services, by transitioning from a technology focus to a focus on function, by switching from a purchase model to a model whereby products and services are shared, to higher digitization and automation, and embedded working environments with a social conscience and value-added systems in industrial companies. To this end, there must be an increase of R&D among SMEs and stronger cooperation with training centers and universities. The willingness to own a business, engage in entrepreneurial activity and to become invested in business and society must be promoted and encouraged. Universities often find partners among large companies that are not located in Saxony. Notwithstanding the high daily workloads of individuals, incentives must be created for industry, but also for universities and non-university research institutions in the Free State of Saxony to engage in dialogues and cooperation networks (joint research projects, but also lower-threshold information exchange). Economic

development must be supplemented by the targeted promotion of competencies. This can be accomplished by harnessing technical and business management expertise from SMEs, which comprise the majority of companies in the Free State of Saxony (e.g. business management expertise from managers in SMEs, craftsmen and technicians; exchanges on new technologies and processes with universities, e.g. via trade shows, science slams, coaching of companies by scientists and business angels; trips abroad by Saxon ministers with SMEs, etc.). When approving funding for programs, ecological and social sustainability factors must be taken into account for both the funding and implementation of measures.
One example of tools that are supporting the regional economy in the sense of *"from the region for the region"* are regional currencies, e.g. the Elbtaler[34] for Dresden and Lusatia. These systems are sustainable financial instruments that stimulate intra-regional procurement and draw purchasing power to the region by anchoring the means of payment in the region. Regional cycles are strengthened as value chains shift to the region and liquidity is kept in the state. Participating companies use these special currencies as an additional financial instrument in parallel to the euro. For consumers, regional currencies offer a stronger influence on value chains by inducing the payee to purchase regional supplies when paying with regional currency.

4.5.4 Action field: Infrastructure

A solid *infrastructure is a necessary and central prerequisite* for sustainable development. This includes mobility, digital communication, attractive living spaces, sustainable resource management of natural capital, a future-oriented education system and an efficient health care system.

Mobility: Fast and frequent connections to nearby capitals and centers such as Berlin, Prague, Wroclaw etc. must be promoted immediately by investing in transport infrastructure linking the Free State of Saxony to national and international transport hubs. An attractive local public transport system (ÖPNV) providing rural areas with quick and comfortable connections to larger cities must be expanded throughout Saxony and also (nationally) across the states. The Trilex[35] can be viewed as a good example for transport links to Poland and the Czech Republic, contributing to a high quality of life and housing in the centers and in the regions. A coordinated development of the two international Saxon airports into efficient and attractive hubs that complement each other must also be undertaken. A well-developed bike lane system that runs through the cities but also extends to surrounding areas is of high and growing importance for sustainable development. With the increase of electric bikes, this is bound to have an important role in urban and regional development as an attractive mobility option especially for commuters.

[34] Learn more at www.elbtaler.de

[35] Learn more at http://www.laenderbahn.com/trilex/

Digital infrastructure: All regions of the Free State of Saxony must receive an extensive broadband expansion, even across the entire area. This is designed to facilitate digital communication even in remote regions, as this has become an important competitive factor for business and science. The use of the digital infrastructure, which represents an equally important basis for sustainable development, is expected to see another strong increase among various user groups.

Quality of life: Intertwined with the infrastructure above, the cultural landscape of the Free State of Saxony and the outdoors[36] contribute to a high quality of life. Every population center is linked to a nature region: the castles and heathlands are linked to Leipzig, the Elbe valley to Dresden, the Ore Mountains to Chemnitz. By strengthening and expanding local public transport services to increase frequency (e.g. every 30 minutes, longer cycles on weekends) and coordination of schedules between different operators, local recreation areas in addition to Saxon Switzerland, the Vogtland and Upper Lusatia can be reached more quickly while providing an alternative to the car that is available at all times. By the same token, regions with a weaker industrial base will receive better links to population centers that allow commuters to travel back and forth between work and their homes in the suburbs. To sum it all up, the Free State of Saxony is blessed with natural wealth, which, along with its cultural offerings *"from the region, for the region"* make for a wide range of recreational opportunities.

Natural capital: The outdoors not only serves recreational purposes, but its natural capital in the form of renewable and non-renewable resources (plants, animals, air, water, soil, minerals etc.) also forms the basis for economic activity in the Free State of Saxony. This brings us full circle to the topic of wood and the mining captain Hans Carl von Carlowitz, whose ideas covered mining, the timber and forestry industry, wood as a resource, and by extension, plants as nature’s capital.

Education: Saxony regularly scores very well in evaluations of school education (Education: in student comparison tests Saxony and Bavaria are ranked at the top. (2016, October 27). A good school education is an important prerequisite for the future of the Free State. Hence, it is important to maintain a good ranking. Currently, trends in teacher training indicate that major strategic efforts will be required: matching long-term plans for teacher requirements with training capacities, personal efforts, e.g. targeting school leavers holding a diploma from a college prep school (Abitur) and those interested in training for high-demand occupations with information campaigns; support and encouragement by teachers and school agencies, and financial efforts (e.g. higher salaries). This is the only way to make up for the loss of experienced teachers to retirement and to restore the appeal of the teaching profession while competing with other states. To succeed, jobs in the education sector must become more attractive and, above

[36] Learn more at https://www.sachsen-erkunden.de/category/freizeit/

all, the education system must produce well-qualified teachers. New and innovative teaching approaches must also be incorporated into training. The infrastructure of the educational institutions is also of great importance, since it has been affected by a massive investment backlog in the Free State of Saxony, as well as throughout Germany. This investment backlog affects both building construction and the modernization and digitalization of equipment and must be eliminated immediately. Vocational training must be adapted to meet the expected rise in demand for skilled workers. Universities are important nuclei of crystallization for sustainable development: they give workers and managers skills and spawn innovative companies, which must be strengthened further. To this end, attention should be given to specific areas of concentration as opposed to covering all topics broadly. In addition, vocational training in the Free State of Saxony should also be expanded in a targeted manner.

High-growth health care services: Medical care and preventive care, but also therapy, as well as excellent nursing care services must be guaranteed by a high-performing health care system in all phases of life, both in population centers and in rural areas, with appropriate specialist staff. To this end, the health system must be prepared for current challenges such as a higher proportion of older people and an increase in mental illness. Medical professionals, especially family doctors, provide basic care *"from the region for the region"*. In rural areas in particular, specialist care can be improved by telemedical developments in the shape of *"digital engineering"* and by linking outpatient and inpatient facilities with interdisciplinary services. At the same time, *"groundbreaking projects"* in medicine are boosting research in and development of new treatment or preventive treatment options.

4.6 Monitoring - sustainability diagnostics

In order to direct the implementation of an industrial sustainability strategy and to adapt it as needed, it is necessary to measure and monitor its progress. For this purpose, performance measurement systems such as the Balanced Scorecard[37] have been developed in areas of economic study in recent years. Such systems have been used successfully for many years in both the private and public sector. Based on the sustainability strategy of the Free State of Saxony, various perspectives can be developed to measure sustainability goals with the help of quantitative indicators such as the proportion of forest in the Free State of Saxony. This facilitates the comparison of planned and actual data, providing yardsticks for a progress check. In addition, each target can be linked to measures required to achieve it. This adds more rigor to strategy implementation, since specific activities for implementation must be described. It is also essential to clarify how often the indicators are collected and what data sources are to be used.

[37] Balance Scorecard is used for measuring, documenting and managing the implementation of strategies.

The system of indicators developed can be used both diagnostically in the sense of a comparison of planned/actual data and thus as an implementation control element, and interactively as a basis for the further development, refinement or adaptation of the industrial sustainability strategy by politicians, companies or associations. The Sustainability Report of the Free State of Saxony has already evaluated several indicators. Based on the recommendations for action given here, the indicators should be further refined and the sustainability assessment further developed. Beyond indicators, the development of a control system is urgently needed to monitor and control the implementation of the sustainability strategy for the Free State of Saxony.

5 Accompanying risk analysis

Each development process is accompanied by obstacles or disruptive factors that can slow down, hinder or completely block the process. On the one hand, the avoidance of new debts may give future generations some relief; but on the other hand, necessary investments will be postponed. The importance of the analysis and the removal of obstacles to the future of industry in the Free State of Saxony are tied to the successful implementation of goals and measures in all areas. In order to counteract demographic change, Saxony must become an immigration region. Particularly in innovation processes, it has been observed that new ideas often fail only because obstacles to their implementation have not been overcome (cf. Hauschildt/Gemünden 1999, p. 13). Here, the interaction of all actors is important: power promoters decide on strategies and promote processes that enhance their position in the hierarchy. Specialist promoters, on the other hand, are people who can drive the implementation of decisions on the basis of their specialist knowledge. Drivers of risks can be the complexity of the processes, the number of actors involved, responsibilities, power structures, lack of resources, but also routines and personal commitment.

Therefore, it is recommended that possible obstacles in innovation processes be assessed and that there will be no immediate course changes in the event of problems in the implementation process, but rather inquiries into obstacles impeding the process. A systematic approach is recommended here. Only if the obstacles are kept in check proactively, can the gap between the starting point and the desired goals be closed.

And how can our great goals best be accomplished, our opportunities best be exploited and our challenges of sustainability for the future of Saxon industry best be met? By reinventing Saxony!

Bibliography

Bernhofer, C., Heidenreich, M., & Riedel, K. (2013). Faktenblatt Regionaler Klimawandel http://www.regklam.de/fileadmin/Daten_Redaktion/Publikationen/130122_Faktenblatt_regionaler-Klimawandel.pdf.

Bildung: Schüler-Vergleichstest: Sachsen und Bayern vorn. (2016, October 27). *Die Zeit.* Hamburg. http://www.zeit.de/news/2016-10/27/bildung-schueler-vergleichstest-sachsen-und-bayern-vorn-27201603. Accessed: 19 December 2017

Federation of German Industries (Ed.). (2016). *Deutschland 2030 - Zukunftsperspektiven der Wertschöpfung*. Berlin: BDI - Federation of German Industries

Carlowitz, H. C. von. (2000). *Sylvicultura oeconomica – oder Anweisung zur wilden Baumzucht* (reprint of the Leipzig edition 1713). Freiberg i.S. http://digital.slub-dresden.de/werkansicht/dlf/85039/127/. Accessed: December 19, 2017

CDU Regional Association Saxony, & SPD Regional Association Saxony (Ed.). (2014). Sach sen Zukunft gestalten. Koalitionsvertrag 2014-2019 zwischen der CDU Sachsen und der SPD Sachsen. https://www.staatsregierung.sachsen.de/downloads/AKTUELL_Koalitionsvertrag_CDU_SPD_2014-2019.pdf

Cooper, H. M. (1982). Scientific Guidelines for Conducting Integrative Research Reviews. Review of Educational Research, 52(2), 291-302. doi:10.3102/00346543052002291

DIN German Institute for Standardization. (2014). *DIN SPEC 35811:2014-08 Szenarioplanung – Empfehlungen für Entscheidungsprozesse im Zusammenhang mit dem Klimawan del*. Berlin, Germany.

European Commission. (2015). *Den Kreislauf schließen - Ein Aktionsplan der EU für die Kreislaufwirtschaft* (No. COM (2015) 614 final) (p. 25). Brussels. http://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0004.02/ DOC_1&format=PDF

European Environment Agency (Ed.). (2015). Assessment of global megatrends. https://www.eea.europa.eu/soer-2015/global/action-download-pdf/at_download/file

Günther, E., Stechemesser, K., Meyr, J., Hermann, J., & Bergmann, A. (2013). Faktenblatt Baugewerbe. http://regklam.de/fileadmin/Daten_Redaktion/Publikationen/Faktenbl%C3%A4tter/baugewerbe_fertig_2013-07-04_FINAL_db.pdf

Krippendorff, K. (2009). *Content analysis*. Thousand Oaks: Sage.

Saxon State Ministry for Environment and Agriculture (SMUL) (Ed.). (2013). Sachsen hat Zukunft. Nachhaltigkeitsstrategie. https://www.smul.sachsen.de/download/verwaltungsportal/nachhaltigkeitsstrategie_smul.pdf.. Accessed: 2 December 2017

Saxon State Ministry for Environment and Agriculture (SMUL) (2016) Sachsen hat Zukunft. Nachhaltigkeitsbericht https://publikationen.sachsen.de/bdb/artikel/27427/ documents/41147

Saxon State Ministry of Economics, Labor and Transport (ed.) (2013) Innovationsstrategie des Freistaates Sachsen. http://www.innovationsstrategie.sachsen.de/download/Innovationsstrategie_des_Freistaates_Sachsen.pdf

PRISMA (2017) Ordnung des Kompetenzzentrums PRISMA Zentrum für Nachhaltigkeitsbe wertung und –politik. https://tu-dresden.de/prisma/ressourcen/dateien/PRISMA-Ordnung.pdf?lang=de

VDI/VDE Innovation + Technology. StrategieWerkstatt Industrie der Zukunft (Ed.). (2016). Rahmenbedingungen, Herausforderungen und Perspektiven für die sächsische Industrie.

Wörten, C., Keppler, L., & Holzhausen, G. (2017). Arbeitsplätze in Braunkohleregionen – Entwicklungen in der Lausitz, dem Mitteldeutschen und Rheinischen Revier. Arepo Consult.