LAND
BRANDENBURG

# MASTER PLAN PLASTICS AND CHEMISTRY

## SUSTAINABLE DEVELOPMENT IN THE BERLIN-BRANDENBURG CAPITAL REGION

THE GERMAN CAPITAL REGION
excellence in plastics & chemistry

# Master Plan for the Cluster Plastics and Chemistry Brandenburg

# Contents

# 1 Introduction and framework

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With the Master Plan of 2014, the Cluster Plastics and Chemistry Brandenburg focused on three specific fields of action with particularly high innovation potential and growth opportunities in the market: “Bio-based speciality chemicals”, “Biopolymers” and “Lightweight construction/composites”. In addition, there were three cross-sectoral topics of relevance to the industry: “Locations for the plastics and chemical industry”, “Logistics for the plastics and chemical industry” and “Securing skilled employees for the plastics and chemical industry”. The results in terms of content and structure achieved in the Cluster together with the players from industry and scientific institutions have had an impact and are based on agreements in the Master Plan.

However, the framework has changed significantly since the publication of the first Master Plan in 2014; particularly the global challenges in the field of sustainability have continued to increase. The structural change in Brandenburg is already associated with massive transformations of the framework of the industrial economy as well as the employment fields of the working population. This updated Master Plan actively addresses new challenges with the field of action “Markets and technologies”. Furthermore, the Cluster is facing new challenges in the context of digitalisation. This circumstance is also taken into account in this update of the Master Plan Plastics and Chemistry Brandenburg.

Both the plastics industry as well as the chemical industry are undergoing change. Sustainability is a topic that the Cluster Plastics and Chemistry has been working on for some time. Many companies and institutions are already facing this challenge today. Sustainability here means not only ecological goals but also social and economic sustainability, so that product and process innovations can develop their full effect. The new Master Plan therefore anchors the idea of sustainability as a model for the plastics and chemical industry in Brandenburg and seizes it as an opportunity for the competitiveness and future viability of the Cluster players. In the coalition agreement of the Brandenburg state government, which was drawn up at the same time as the Master Plan, it was explicitly agreed that all Master Plans should be focused on ecological and social challenges.[1] All fields of action of the Master Plan will actively address this demand.

The Master Plan is based on the Regional Innovation Strategy of the State of Brandenburg, which will be updated in 2019 as innoBB 2025 plus and will provide new impetus to make technological, economic and social developments a success for the region. The key focal topics “Digitalisation”, “Real-world laboratories and test fields”, “Work 4.0 and skilled employees” as well as “Start-ups and new businesses” set the framework for the further development of the Cluster and for mastering the challenges in a dynamic environment.

In essence, the Master Plan consists of a presentation of the fields of action with the respective strategic objectives. Exemplary thematic areas within the fields of action are used to outline current and emerging opportunities in Brandenburg and to highlight particular priorities for action. The measures and activities proposed by the Cluster players in the course of the Master Plan process are compiled in a separate Cluster document and updated throughout the ongoing work in the Cluster.

## 1.1 Tasks of the Cluster

The Cluster Plastics and Chemistry regards itself as a supporting and driving link between industry and science, networks and lobbies, chambers, politics and public administration in Brandenburg as part of the industrial nation of Germany. In this capacity, it acts as a signpost and impulse generator with the aim of actively supporting all partners and securing and developing the innovative and competitive capacity of the regional economy. To this end, knowledge and competencies are expanded in a targeted and demand-oriented manner and opportunities are identified for the Cluster players in order to jointly master the challenges in the industries.

To achieve this, the Cluster offers its players active, coordinating and communicative support in

- the identification of innovation and growth potential
- networking and development of cooperation projects
- the promotion of knowledge and technology transfer

1 Coalition agreement of the parties SPD, CDU and Bündnis 90/Die Grünen, version dated 25/10/2019, https://www.brandenburg.de/media/bb1.a.3780.de/191024_Koalitionsvertrag_Endfassung.pdf, accessed 13/11/2019.

- networking the players and internationalisation of the Cluster
- identification and development of synergies with other clusters
- securing and developing a skilled workforce
- ensuring an optimal logistics connection to regional markets
- ensuring decent work in cooperation with company co-determination
- the presentation of the performance and innovation capability of the Cluster as well as the acting players through active Cluster marketing

Acting in a coordinating function, the Cluster management represents the interface between the individual players and committees. The Cluster is represented externally by the Cluster spokesperson. The Cluster Advisory Board, consisting of representatives from industry, science, associations, networks and social partners as well as the state government and the Economic Development Agency Brandenburg (WFBB), is responsible for the strategic and content-related orientation of the Cluster as a whole and the goals pursued in the individual fields of action. The Cluster Advisory Board is headed by the Cluster spokesperson. In the individual fields of action, field spokespersons are responsible for ensuring the exchange of information between the players involved and coordinating measures for the further development of the fields of action.

Cluster work has achieved numerous successes in recent years, which are reflected in economic statistics and concrete measures. For instance, since 2014, the Innovation Prize for Plastics and Chemistry has been awarded by the Ministry for Economic Affairs, Labour and Energy to companies that provide new impetus with outstanding ideas and solutions.

Innovative ideas are also at the forefront of the research and development projects that were and are being initiated with the support of the Cluster. In 2017 and 2018 alone, 58 projects were initiated, which involve not only regional but also national and international partners and partners from other clusters (cross-clusters).[2]

With the campaign “Nachhaltig heute in Brandenburg” [“Brandenburg – Sustainable Today”], launched in 2017, a special focus is already being placed on the topic of sustainability. The campaign’s web presence illustrates in words, pictures and video where sustainable management, work and research is already being carried out in Brandenburg today.[3]

## 1.2 Tasks of the Master Plan – necessity of updating

The Master Plan is a common **strategic working basis** and **design tool** of the Cluster in the cooperation of industry, science, administration and economic development of the State of Brandenburg. It lays the foundation for the Cluster work of the coming years.

The aim of the Master Plan is to identify technological and application-related research, development and innovation topics that are of current and future importance, both from industry and science, including the cross-sectoral and integrative topics relevant to the Cluster, in order to then coordinate them within the framework of the objectives of the innovation strategy of the State of Brandenburg (innoBB 2025 plus) and implement them with the available resources.

As the Cluster has evolved since the publication of the first Master Plan in June 2014, so has the **framework** that influences work in the Cluster’s industries. Changes in the regulatory environment have to be taken into account, as do **new content-related key focal points** in the Cluster industries and **economic** and **technical developments**, especially on **sustainability** issues.

2 Ministry for Economic Affairs, Labour and Energy (ed.) (2019): Jahresbericht 2018 zum Ergebnis- und Wirkungsmonitoring. [2018 Annual Report on Results and Effects Monitoring] Cluster Plastics and Chemistry, Potsdam.

3 Initiative “Nachhaltig heute in Brandenburg” [“Brandenburg – Sustainable Today”] of the Economic Development Agency Brandenburg (WFBB) to highlight the various entrepreneurial efforts for sustainability and to encourage people and companies to get involved in Brandenburg in a sustainable way, https://nachhaltigheute.de/.

## 1.3 Overall objectives and political framework

The Master Plan is based on the requirements of the players of the Cluster. In addition, there are overriding objectives and political frameworks that are substantiated in strategies and laws at state, federal and European level. These must be taken into account when formulating the Master Plan.

The **Regional Innovation Strategy of the State of Brandenburg** updated in 2019 (innoBB 2025 plus[4]) for the four Brandenburg-specific clusters has a structuring influence on the work of the Cluster Plastics and Chemistry and defines the strategic framework of innovation policy and thus the content orientation of the clusters to complement the Joint Innovation Strategy of the States of Berlin and Brandenburg (innoBB 2025[5]). The innoBB 2025 plus formulates guidelines that provide for an expansion and opening of innovation efforts and a prioritisation of sustainable innovations. Cross-industry, cross-cluster cooperation and the international presence of the clusters are to be reinforced. A further focus is on the creation of innovative value chains. An increased use of biogenic raw and residual materials in line with a sustainable bioeconomy is also planned. The focus will also be on the repair and recycling possibilities of materials and components. The key focal points for the clusters were identified as digitalisation, real-world laboratories and test fields, Work 4.0 and skilled employees as well as start-ups. A detailed presentation of the interrelation of the objectives, measures and activities of the fields of action with the innovation strategy of the state is provided in Chapter 5 Key focal points and guidelines.

The **coalition agreement** of the new state government specifies concrete key focal points for the legislative period 2019 to 2024, especially with a central commitment to sustainability and the sustainability strategy of the federal government[6]. The State of Brandenburg already has a **sustainability strategy**[7] which aims to align the economy towards sustainable development and to use the economic potential of natural resources for sustainable regional development. This is being revised and aligned[8] with the United Nations Agenda 2030.

The Master Plan is also based on the **"Brandenburg Industrial Policy Guidelines"**[9], which identify innovation and digitalisation as well as securing skilled employees and qualification as important operative fields of action.

At the national level, it is particularly the **"High-Tech Strategy 2025"**[10] that points the way forward with its objectives of "substantially reducing the input of plastics into the environment", achieving "extensive greenhouse gas neutrality for industry" and "sustainable management in cycles". The **"National Bioeconomy Strategy"**[11] takes this up with the objectives of "expanding biological knowledge through research, creating bio-based innovations through biological knowledge, conserving natural resources through bio-based innovations, combining ecology and economy through resource conservation, ensuring sustainability through bioeconomic solutions".

At the European level, the strategy **"A sustainable bioeconomy for Europe"**[12]**,** which pursues the goal of a sustainable and circular European bioeconomy, and the **"European Strategy for Plastics in a Circular Economy"**[13], which aims at an "intelligent, innovative and sustainable plastics industry", support the efforts of the federal government, the state and the Cluster Plastics and Chemistry to create a sustainable plastics and chemical industry.

4 innoBB 2025 plus | Regional Innovation Strategy of the State of Brandenburg innoBB 2025 plus, adopted on 4 June 2019 by the Government of the State of Brandenburg.

5 Joint innovation strategy of the States of Berlin and Brandenburg innoBB 2025, adopted by the two state governments in January 2019.

6 The Federal Government (2018): Deutsche Nachhaltigkeitsstrategie – Aktualisierung 2018 [German Sustainability Strategy – Update 2018], https://www.bundesregierung.de/resource/blob/975274/1546450/65089964ed4a2ab07ca8a4919e09e0af/2018-11-07-aktualisierung-dns-2018-data.pdf?download=1, accessed 13/11/2019.

7 Ministry of the Environment, Health and Consumer Protection (2014): "natürlich. nachhaltig. Brandenburg. Nachhaltigkeitsstrategie für das Land Brandenburg" [natural. sustainable. Brandenburg. Sustainability Strategy for the State of Brandenburg], Potsdam.

8 Coalition agreement of 25/10/2019, Chapter 4 "Sustainability", p. 58.

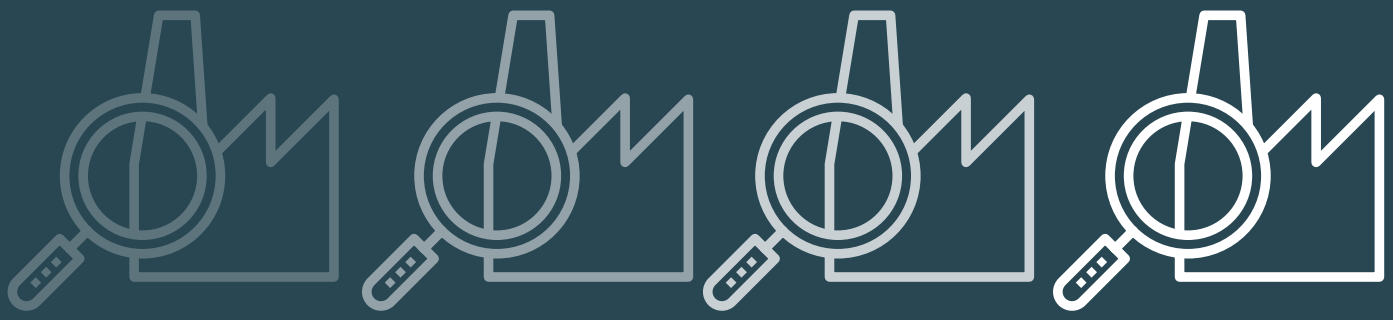
9 Ministry for Economic Affairs, Labour and Energy of the State of Brandenburg (2019): Leitlinien Industriepolitik Brandenburg [Brandenburg Industrial Policy Guidelines], Potsdam.

10 Federal Ministry of Education and Research (2018): Hightech-Strategie 2025. Forschung und Innovation für die Generationen heute und morgen [High-tech strategy 2025. Research and innovation for today's and tomorrow's generations], Berlin.

11 Bioeconomic Strategy of the Federal Government, Cabinet version, 15/01/2020.

12 European Commission (2018): A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated Bioeconomy Strategy, Brussels.

13 European Commission (2018): European Strategy for Plastics in a Circular Economy. COM (2018) 28 final, Brussels.



# 2 The Cluster Plastics and Chemistry Brandenburg

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## 2.1 Sector structure

Plastics and chemicals are two industry sectors that shape Brandenburg's economy and have a regional and national impact. As suppliers to many industries, both at home and abroad, the companies in the Cluster make an important contribution to the global value creation network with their products and services.

Together, the Cluster comprises 13,620 employees subject to social insurance contributions, who generate a turnover of around 3.73 billion euros in 571 companies.[14] The figures below show how many companies were listed in Brandenburg in 2018 with more than 20 employees subject to social insurance contributions:

- 32 chemical companies
- 81 companies manufacturing plastic and rubber products[15]

This makes the Cluster Plastics and Chemistry one of the smaller Brandenburg-specific clusters, albeit one that is economically very powerful.

Companies in the plastics and chemical industry, ranging from regionally oriented microenterprises to global corporations, are spread throughout the state and contribute to economic development and employment. Furthermore, there are the chemical and industrial locations Schwedt/Oder, Premnitz, Guben, Schwarze Pumpe and Schwarzheide as well as the Prignitz region and the Ruppiner Land with their mix of medium-sized and structurally significant large companies.

## 2.2 Research landscape in Brandenburg

The diverse knowledge and research landscape of the capital region Berlin-Brandenburg with its considerable concentration of universities and non-university research institutes in the field of plastics and chemistry provides an indispensable basis for a strong location. From basic research and application-oriented development to qualification in the various sub-disciplines, the region is home to institutions that have made a name for themselves as teaching and research locations on a regional, national and international level and are recognised as partners for the regional economy.

### 2.2.1 University locations

Five universities in Brandenburg work on research topics specific to plastics and chemistry and also provide services. In addition, some of the universities offer expertise in production technology and digitalisation. There are also universities in neighbouring states with which the Cluster cooperates closely. Examples are listed in the following table.

14 Data on the number of companies and turnover refer to the year 2017, data on employees subject to social insurance contributions refer to the year 2018. Source: Ministry for Economic Affairs and Energy (2019).

15 Source: Office for Statistics Berlin-Brandenburg, 2018.

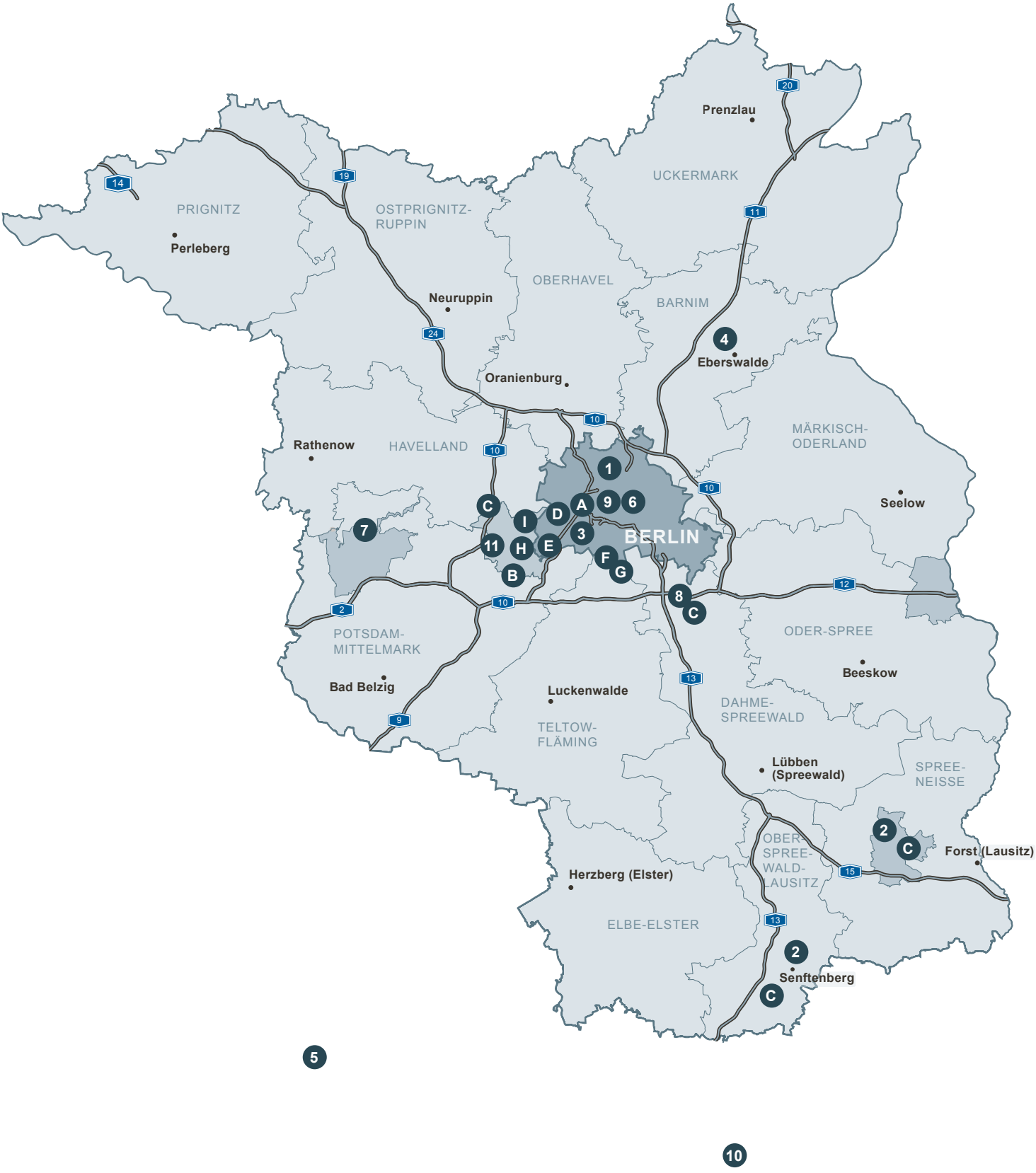


Figure 1: Universities (numbers) and non-university research institutes (letters) related to the Cluster Plastics and Chemistry Brandenburg

Table 1: Universities with Cluster relevance in Brandenburg and neighbouring federal states, including a selection of their key focal points

| University | Key focal points (selection) |
|---|---|
| **1. Beuth University of Applied Sciences, Berlin**<br>www.beuth-hochschule.de | **Department II – Mathematics – Physics – Chemistry**<br><br>**Department VIII – Mechanical Engineering, Event Technology, Process Engineering, Laboratories**<br>• Inorganic and analytical chemistry and services<br>• Chemical and pharmaceutical technology<br>• Plastics processing and testing<br>• Organic and macromolecular chemistry and services<br>• Physical chemistry<br>• Thermal process engineering |
| **2. Brandenburg University of Technology Cottbus-Senftenberg**<br>www.b-tu.de | **Faculty 2 – Environment and Natural Sciences**<br>*Institute of Materials Chemistry*<br>• Inorganic chemistry<br>• Materials chemistry<br>• Organic and pharmaceutical chemistry<br>• Physical chemistry<br>• Technical chemistry<br>• Polymer materials<br>*Institute of Environmental and Process Engineering*<br>• Chemical reaction technology<br>• Process and plant technology<br><br>**Faculty 3 – Mechanical Engineering, Electrical and Energy Systems**<br>*Institute of Mechanical Engineering and Management*<br>• Biopolymers and plastics processing<br>• Materials science<br>• Factory planning and operation<br>*Institute of Production Research*<br>• Polymer-based lightweight design |
| **3. FU Berlin**<br>www.fu-berlin.de | **Department of Biology, Chemistry, Pharmacy**<br>• Biochemistry and relationship to pharmacy<br>• Supramolecular architectures at biological interfaces<br>• Molecular research, stereoselective and macromolecular synthesis<br>• Biomedical research, medical biochemistry, and structural biochemistry<br>• Nanoscale functional materials, nanotechnology<br>• Function and chemical reactivity |

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| **4. Eberswalde University for Sustainable Development**<br>www.hnee.de | **Faculty of Wood Engineering**<br>• Working Groups Chemistry and Physics of Wood and madera wood research |
| **5. Merseburg University of Applied Sciences**<br>www.hs-merseburg.de | **Department of Engineering and Natural Sciences**<br>• Chemical and environmental technology<br>• Green engineering<br>• Mechanical engineering, mechatronics, physics |
| **6. Humboldt University of Berlin**<br>www.hu-berlin.de | **Faculty of Mathematics and Natural Sciences**<br>*Institute of Chemistry*<br>• General and inorganic chemistry<br>• Analytical and environmental chemistry<br>• Organic and bio-organic chemistry<br>• Physical chemistry<br>• Theoretical chemistry |
| **7. Brandenburg University of Applied Sciences**<br>www.th-brandenburg.de | **Department of Engineering**<br>• e.g. manufacturing and production technology, materials testing, etc.<br>**Department of Business and Management**<br>• e.g. production optimisation and logistics systems, etc. |
| **8. Wildau Technical University of Applied Sciences**<br>www.th-wildau.de | **Research field 4: Production and Materials**<br>• Research Group Composite Material Technologies<br>• Research Group Polymer High-Performance Materials<br>• Research Group Transport Logistics<br>**IMEP Institute for Material, Development and Production**<br>**Institute of Life Sciences and Biomedical Technologies**<br>• Biosystems technology, including characterisation of conductive or switchable polymers, investigation of polymer films<br>• Research Group Microsystems Technology/Systems Integration, including polymers for medical technology<br>**Joint lab: Leibniz Institute IHP/TH Wildau**<br>• Photonics, laser and plasma technologies, including validation and further development of electron-activated vacuum deposition (EVD) for the deposition of thin, defect-free polymer or polymer composite layers<br>• Research Group Polymer High-Performance Materials<br>• Research Group Microsystems Technology/Systems Integration, including polymers for medical technology<br>• Research Group Transport Logistics<br>• Department of Factory Planning and Factory Operation with the model factory “Zentrum Effiziente Fabrik Senftenberg” (ZEF) |

| | |
|---|---|
| **9. TU Berlin**<br><br>www.tu-berlin.de | **Faculty II – Mathematics and Natural Sciences**<br>*Institute of Chemistry*<br>• Inorganic and analytical chemistry<br>• Organic chemistry<br>• Physical and theoretical chemistry<br>• Technical chemistry<br>*with a variety of specialised fields, including bioinorganic chemistry, natural product-oriented synthesis chemistry, biocatalysis, bioenergetics of solar fuels*<br><br>**Faculty III – Process Sciences**<br>*Department of Polymer Technology and Polymer Physics*<br>• Plastics in the manufacturing process<br>• Material and component development, including natural fibre composites, renewable raw materials, recycling of plastic products<br>• Medical technology applications |
| **10. TU Dresden**<br><br>www.tu-dresden.de | **School of Science**<br>*Faculty of Biology, Chemistry and Food Chemistry*<br>• Inorganic chemistry<br>• Organic chemistry<br>• Physical chemistry<br>• Analytical chemistry<br>• Macromolecular chemistry<br>• Food chemistry<br>• Biochemistry<br><br>**School of Engineering Sciences**<br>*Faculty of Mechanical Engineering*<br>• Process engineering and natural materials technology<br>• Materials science<br>• Mechanical engineering |
| **11. University of Potsdam**<br><br>www.uni-potsdam.de | **Faculty of Mathematics and Natural Sciences**<br>*Institute of Chemistry, working/research groups:*<br>• Inorganic chemistry<br>• Organic and analytical chemistry<br>• Physical and theoretical chemistry<br>• Polymer and colloid chemistry<br>• Didactics of chemistry<br>• Functional nanostructures |

### 2.2.2 Non-university research institutes

The non-university research institutes based in Brandenburg with relevance to the Cluster have a broad and highly specialised spectrum of expertise in the field of plastics and chemistry. In addition, there is cooperation with non-university research institutes in Berlin.

Table 2: Non-university research institutes with Cluster relevance in Brandenburg including a selection of their key focal points

| Research institute | Key focal points (selection) |
|---|---|
| **A. Federal Institute for Materials Research and Testing (BAM)**<br>www.bam.de | **Departments**<br>• Analytical chemistry; reference materials<br>• Chemical safety engineering<br>• Containment of hazardous goods<br>• Material and environment<br>• Materials science<br>• Material protection and surface technology<br>• Non-destructive testing |
| **B. German Research Centre for Geosciences (GFZ)**<br>www.gfz-potsdam.de | **Department of Geochemistry**<br>• Inorganic and isotopic geochemistry<br>• Organic geochemistry<br>• Fluid system modelling<br>• Interfacial geochemistry<br>• Chemistry and physics of geomaterials |
| **C. Fraunhofer Institute for Applied Polymer Research (IAP)**<br>www.iap.fraunhofer.de | **Biopolymers**<br>• Lignocellulose<br>• Starch modification / Molecular properties<br>• Fibre technology<br>• Material development and structural characterisation<br><br>**Functional polymer systems**<br>• Functional materials and components<br>• Polymers and electronics<br>• Chromogenic polymers<br>• Sensors and actuators<br><br>**Synthesis and polymer technology**<br>• Microencapsulation/Particle applications<br>• Polymer synthesis<br>• Membranes and functional films<br>• Shape memory polymers |

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|---|---|
| | **Life science and bioprocesses**<br>• Functional protein systems<br>• Biomaterials and healthcare<br>• Biological building blocks and bioprocess development<br><br>**Pilot Plant Centre PAZ** (Saxony-Anhalt)<br>• Polymer synthesis<br>• Polymer processing<br><br>**Polymer materials and composites PYCO**<br>• Thermosets<br>• Polymer development<br>• Construction<br>• Simulation<br>• Multi-material design<br>• Semi-finished products, materials, FRP<br>• Manufacturing process<br>• Recycling & repair<br>• Alternative curing methods<br>• Fire protection<br>*in the groups*<br>• Polymer development<br>• Semi-finished products<br>• Design & manufacturing<br>• Testing & analytics<br><br>**Center for Applied Nanotechnology CAN** (Hamburg)<br>• Quantum materials<br>• Nanomedical applications<br>• Home and personal care<br>• Nanoscale energy and structural materials |
| **D. Fritz Haber Institute of the Max Planck Society**<br><br>www.fhi-berlin.mpg.de | **Departments**<br>• Inorganic chemistry<br>• Interfacial science<br>• Physical chemistry |
| **E. Helmholtz-Zentrum Berlin for Materials and Energy**<br><br>www.helmholtz-berlin.de | **Division Renewable Energies**<br>• e.g. electrochemical conversion of $CO_2$<br><br>**Division Energy Materials**<br>• including catalysis for energy |

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|---|---|
| **F. Helmholtz-Zentrum Geesthacht GmbH**<br>www.hzg.de | **Institute of Biomaterial Science**<br>• Multifunctional, polymer-based materials for applications in regenerative medicine |
| **G. Institut für Dünnschichttechnologie und Mikrosensorik e. V. (IDM)**<br>www.idm-teltow.de | • Development of synthesis processes for speciality chemicals<br>• Polymers, including synthesis of thermostable polymers and electrically conductive polymers |
| **H. Max Planck Institute of Colloids and Interfaces**<br>www.mpikg.mpg.de | **Colloid Chemistry**<br>• Synthesis of colloidal structures of polymeric units<br>• Biorefinery and sustainable chemistry<br>• Novel self-assembly polymers<br>• Old chemistry for new advanced materials<br>**Mechano(bio)chemistry** |
| **I. Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB)**<br>www.atb-potsdam.de | **Departments**<br>• Bioengineering<br>• Technology assessment and substance cycles<br>**Research programm**<br>• Material and energetic use of biomass |

## 2.3 Networks with relevance to the Cluster Plastics and Chemistry

The companies, science and employees in the Cluster Plastics and Chemistry Brandenburg are supported by networks, chambers, industry and business associations, trade unions and other stakeholders with their contributions to the development of chemical and plastics companies in the State of Brandenburg.

In addition to links with the regionally active players, the Cluster also maintains close cooperation with clusters and networks that operate across borders.

### AKB – Arbeitgeber- und Wirtschaftsverband der Kunststoff Verarbeitenden Industrie Berlin-Brandenburg

The employers' and trade association of the plastics processing industry in Berlin and Brandenburg, AKB, represents the economic and sociopolitical interests of companies in the plastics processing industry in the Berlin-Brandenburg region.

www.akb-kunststoff.de

### Bundesverband Deutsche Startups e. V. – Chemie Plattform

The association has represented more than 900 start-ups in Germany since 2012. The Chemicals Platform from the federal association of German start-ups (Bundesverband Deutsche Startups e. V. – Chemie Plattform) actively addresses strategic and structural developments. The Chemicals Platform sees itself as a contact for sustainable and digital change in chemistry.

www.deutschestartups.org/community/plattformen/chemie/

### BVP Berlin-Brandenburgischer Verband für Polymerforschung

The BVP is an association of universities, non-university research institutes, companies and other players with the aim of promoting, coordinating and systematically developing polymer research and teaching in Berlin and Brandenburg.

bvp.physik.hu-berlin.de

### CeChemNet Central European Chemical Network

CeChemNet is an inter-site network linking six chemical parks in Central Germany.

www.cechemnet.de

### Cluster Chemistry/Plastics Central Germany

A cross-state platform initiated by the industry and comprising SMEs, associations, educational and research institutes, service providers, politicians and administrations in Brandenburg, Saxony, Saxony-Anhalt and Thuringia.

www.cluster-chemie-kunststoffe.de

### Composites United e. V. (CU)

CU (formerly Carbon Composites) is an association of companies and research institutes from Germany, Austria and Switzerland, which are also active in Brandenburg in the field of high-performance fibre-reinforced composites, and has over 200 members.

www.composites-united.com

### DVS – Deutscher Verband für Schweißen und verwandte Verfahren e. V.

The DVS is a technical-scientific association that focuses on the dialogue between all players and on research into joints, including in the non-metallic field. The members are organised in thematic and regional working groups.

www.die-verbindungs-spezialisten.de

### FIRM e. V.

FIRM is a network oriented towards regional project development and technology transfer. Its aim is to strengthen the innovative competence and competitiveness of research and development institutions in connection with companies and local administrations in the long term.

www.firm-ev.de

### GKV Gesamtverband Kunststoffverarbeitende Industrie e. V.

The GKV is the umbrella organisation of the German plastics processing industry. In this role, it pools and represents the common interests of its member associations and communicates these interests to politicians and the general public.

www.gkv.de

**Chambers of Crafts Cottbus, Frankfurt (Oder) and Potsdam**

The Chambers of Crafts are the partner of their members, the general public and politicians. They support their members in their daily challenges and take up future trends and offer potential solutions, from basic, further and advanced training to operational guidance and the application of technical innovations.

www.hwk-cottbus.de
www.hwk-ff.de
www.hwk-potsdam.de

**IG BCE Landesbezirk Nordost**

The north-east regional district of the industrial union represents the interests of its members from the mining, chemical and energy industries (IG BCE) in the states of Berlin, Brandenburg, Mecklenburg-Western Pomerania, Saxony and Saxony-Anhalt. The IG BCE is the initiator and designer of “decent work” and fair payment.

https://nordost.igbce.de

**Chambers of Commerce and Industry Cottbus, East Brandenburg and Potsdam**

The Chambers of Commerce and Industry are the self-governing organisations of the commercial economy in the respective districts. The main tasks include promoting the economy in the districts, advocating the overall interests of the associated companies and promoting, for example, apprenticeships and training.

www.cottbus.ihk.de
www.ihk-ostbrandenburg.de
www.ihk-potsdam.de

**Kunststoff-Verbund Brandenburg Berlin KuVBB e. V.**

The Kunststoff-Verbund Brandenburg Berlin stands for the cooperation, training and public relations of all interested parties in this industry and maintains contacts to other networks and the relevant political bodies.

www.kuvbb.de

**Netzwerk Leichtbau Metall Brandenburg (LMB)**

The network includes companies and institutions involved in lightweight metal construction and hybrid components. In addition to lightweight construction with metals, hybrid components are also considered as lightweight construction solutions.

www.leichtbau-bb.de

**NORKUN – Norddeutsches Kunststoff Netzwerk**

NORKUN is a technology-oriented network with the purpose of supporting cooperation between research, development and industry and the transfer of knowledge in the production, processing and application of plastics internationally and in the northern German federal states. In addition, research capacities for SMEs are arranged, young talent for this industry is promoted in schools as well as in the vocational and university education, and lobbying and qualified external representation for this industry is pursued.

www.norkun-saz.de

**PlasticsEurope Deutschland e. V.**

Association of Plastics Manufacturers in Germany and part of the pan-European organisation PlasticsEurope. PlasticsEurope is one of the leading European trade associations. The association maintains centres in Brussels, Frankfurt, London, Madrid, Milan and Paris and cooperates closely with other European and national plastics associations. More than 100 member companies produce more than 90% of the plastics in the 27 EU member states and Croatia, Norway, Switzerland and Turkey.

www.plasticseurope.de

### POLYKUM e. V.

Due to the important, historically well-established structure of its local chemicals and plastics industry, Saxony-Anhalt was early in developing a stable network landscape, which also has an impact on Brandenburg. A typical example is the activity of POLYKUM e. V. "Association for the Promotion of Polymer Development and Plastics Technology in Central Germany" ["Fördergemeinschaft für Polymerentwicklung und Kunststofftechnik in Mitteldeutschland"]. The network aims to increase the competitiveness of the network players through intensive cooperation and mutual support within the framework of a cooperation network.

www.polykum.de

### PolymerMat e. V.

PolymerMat e. V. is a network which pools the interests of the companies of the plastics industry in Thuringia. It provides a platform for cooperation between companies in the plastics industry in innovation and in the implementation of new technological excellence in the plastics sector. The aim of the association is to support its members, to increase their scope of action through (joint) innovations and to strengthen and expand their market position. Together with POLYKUM e. V., events are planned and carried out to increase the visibility of activities in the economic region of Central Germany.

www.polymermat.de

### POLYSAX

POLYSAX – Bildungszentrum Kunststoffe Bautzen e. V. – is an initiative of industry and industry-related institutions and at the same time a platform for vocational education training in plastics technology, university courses in industrial engineering specialising in plastics technology and in-house training/qualification in Saxony. POLYSAX is your contact for an inspiring, technically demanding apprenticeship or a university course at one of the many companies in the plastics processing industry in Saxony, as well as for opportunities for in-house training.

www.polysax.de

### VCI Verband der Chemischen Industrie e. V., Landesverband Nordost

The Landesverband Nordost of the Verband der Chemischen Industrie e. V. (North-East Chemical Association of the German Chemical Industry Association, VCI) represents the economic policy interests of its member companies. It represents the interests of the chemical-pharmaceutical industry of the states of Berlin, Brandenburg, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt and Thuringia towards policymakers, authorities, organisations, media and the public. It is integrated into the VCI network at federal level and in Brussels. The member companies can contribute to shaping opinion by actively participating in the bodies, committees and working groups of the Landesverband Nordost.

www.nordostchemie.de

### VDI Verein Deutscher Ingenieure, Bezirksverein Berlin-Brandenburg e. V.

The VDI is an association representing engineers and technology. The Bezirksverein (BV) Berlin-Brandenburg is one of 45 VDI district associations. In its region, it is responsible for supporting its currently around 6,000 members and all those interested in technology.

*Working group Plastics Technology*

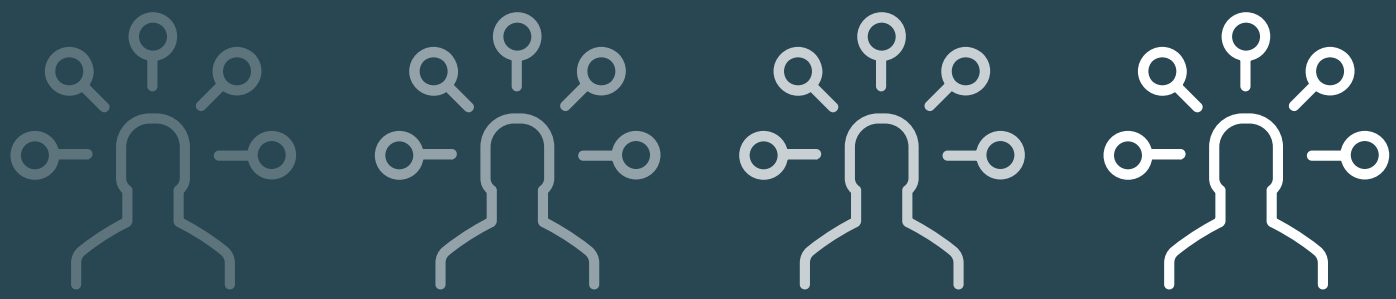
The working group Plastics Technology has set itself the task of presenting the diversity of plastics, their production, processing and possible applications to engineers and supporting them in their daily requirements.

www.vdi-bb.de/ak/kunststoff.php

*Working group Plastics and Lightweight Construction Technologies Cottbus at the Brandenburg University of Technology Cottbus-Senftenberg*

The working group has set itself the general task of presenting plastic-based lightweight construction technologies as a cross-sectoral technology to all players through various events and networking them to pursue activities in this field.

www.vdi-bb.de/ak/kunststoffe_cb.php



# 3 Strategy of the direction of the fields of action

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Since 2014, the fields of action “Bio-based speciality chemicals”, “Biopolymers”, “Lightweight construction/composites”, “Locations”, “Logistics” and “Securing skilled employees for the plastics and chemical industry” have had numerous positive effects on the plastics and chemical industry in Brandenburg. The sustainability topics that were already enshrined at that time have since increased in importance, as have digitalisation and fierce international competition. Securing skilled employees remains one of the central challenges. It is therefore important to continue down the proven path and to develop suitable solutions for the new or intensified challenges.

## 3.1 Opportunities – challenges – framework

The approaches to bio-based speciality chemicals and plastics that have so far been developed in Brandenburg by a number of companies and research institutes form an excellent starting point for the realisation of a sustainable recycling economy and bioeconomy. The specific characteristics of Brandenburg as a state with a strong agricultural and forestry sector are being used to gradually transform the economy from one that is fossil-based to an economy based on renewable resources that works in cycles. Brandenburg acts in accordance with the national bioeconomy strategy of the federal government[16] and the European Union[17]. Bio-based speciality chemicals and starting materials for plastics are already being produced on a pilot scale and/or industrially. New technologies for processing and use as well as findings on recyclability should also be included as opportunities. For example, the scientific institutions in Brandenburg have acquired new expertise in the fields of polymer-based lightweight construction and functional integration in plastics and have initiated corresponding application-related industrial projects. Biofunctional polymers, for instance, have been developed as a new field with a broad application potential.

The improvement of the transport and therefore logistics links between the chemical and plastics locations has already been taken up as a challenge. In addition to the upgrading of the companies through digitally supported production and business processes, the logistics connection is a central prerequisite for international competitiveness. The connection to international corridors for freight traffic[18] and the establishment of intermodal terminals and freight traffic centres has significantly improved the logistical accessibility for companies in Brandenburg.[19] Nevertheless, there remains a need for railway accessibility at other locations in Brandenburg. All those involved cite a sufficient availability of staff as a central challenge for the economic development of the companies. Here it is important to involve those living in rural areas and to attract young people as well as those already in employment for tasks in the plastics and chemical industry.

16 Bioeconomic Strategy of the Federal Government, Cabinet version, 15/01/2020.

17 “A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment”, revised version of the Bioeconomy Strategy of the European Commission, 18/10/2018, https://biooekonomierat.de/aktuelles/eu-stellt-neue-biooekonomie-strategie-vor/, accessed 26/09/2019.

18 Trans-European Transport Network (TEN-T) includes the development of Europe-wide transport routes, especially rail and road routes. https://ec.europa.eu/transport/themes/infrastructure/ten-t_en, accessed 26/09/2019.

19 For example, the closing of the gap in the freight line between Ruhland (Oberspreewald-Lusatia) and Horka (Görlitz district) will enable existing and future companies in southern Brandenburg to have a direct rail connection to Eastern Europe and China.

SWOT analysis

| Strengths | Weaknesses |
|---|---|
| • High research density with significant potential for technology transfer<br>• R&D cooperation in promising areas<br>• Broad coverage of the value chain in chemical parks<br>• Good cooperation between private and public players<br>• Cluster formation and networking<br>• Close links between plastics processing and other industries<br>• Relatively high acceptance of the chemical industry by the population<br>• Predominantly positive development of the plastics and chemical industry in the state | • Relatively small size of the Cluster in comparison to other federal states, resulting in a broad geographical distribution of companies and research institutes<br>• Great dependence of the chemical industry on oil<br>• Value chain often not closed<br>• Relatively low degree of networking within the industry<br>• Relatively low R&D activities and few research staff in SMEs<br>• Lack of unique selling points, no clear occupation of technology fields<br>• Networking of universities and SMEs in the area of personnel transfer developable<br>• Lack of qualified employees, too few trainees |

| Opportunities | Risks |
|---|---|
| • New markets in Asia, Africa, Latin America<br>• New technologies (e.g. bio- and nanotechnologies)<br>• New technological solutions in the context of climate change<br>• Chemicals and plastics industry as problem solvers<br>• Cascade utilisation and joint production for optimal value creation of biogenic raw materials<br>• Rising demand for sustainable products<br>• Substitution of petroleum for new materials (e.g. fibre composites)<br>• Global significance of the industrial use of biogenic raw materials is increasing | • High energy and raw material costs<br>• Availability of raw materials<br>• Fragmented value chains<br>• Relocation of production facilities to the raw material base or to the user industry<br>• Increased competition with companies in Asia and Latin America<br>• Decreasing supply of skilled workers and tendency of academically oriented people to migrate<br>• Low productivity and research and development activities of the economy |

In order to meet the requirements of a sustainable bioeconomy from an economic point of view, clearly defined $CO_2$ saving effects in the biogenic value creation must be made visible. This also includes the cost-effective use of renewable energies. Here, designated real-world laboratories and test fields[20] can develop and test incentive mechanisms through improved, more flexible energy cost components. The provision of demand-oriented information infrastructure is also an important framework condition, which is being further developed in Brandenburg with the initiatives launched by the state and federal government.[21]

## 3.2 Further development of the existing structure of the fields of action

The working structures of the fields of action are well established and represent an important success factor in the implementation and further development of the goals set. In keeping with the comprehensive sustainability requirements, consideration is given not only to biogenic production but also to the requirements of recycling management and energy and resource efficiency.

The present Master Plan pursues the approach of offering technologically and economically attractive goals with an **innovative perspective**. For the companies in particular, it is important to find solutions that are as specific and implementable as possible and that are open to new technologies. The structure of the fields of action with complementary integrative topics creates the ability to fit in with the overall innovation strategy of the states of Brandenburg and Berlin (innoBB 2025 plus).

In a further development of the previous **specialist structure**, the fields of action “Sustainable speciality chemicals” and “Sustainable plastics industry” have emerged from the fields of action “Bio-based speciality chemicals” and “Biopolymers” and now, under the umbrella of sustainability, also include the topics of bioeconomy, energy and resource efficiency and recycling. The term “lightweight construction/ composite materials” has also been expanded to include the concept of sustainability in order to better cover sustainable production and material recycling in this area. The new field of action has been extended to include plastics processing so that processing technologies can also be included in the Master Plan. As **cross-sectoral topics relevant to the industry**, “Locations and logistics for plastics and chemicals” and “Securing skilled employees for the plastics and chemical industry” continue to be central fields of action. Due to the close cooperation of the players in the previous fields of action “Locations” and “Logistics”, these will be combined into one field of action in organisational terms. **The field of action “Markets and technologies” will be newly established** to detect new trends and areas of potential and assess their relevance for the Cluster’s players. The tasks here represent a service and communication function for the other fields of action and form a common interface for cross-cluster topics with the other clusters in Brandenburg and Berlin. The interaction of the three specialist fields of action with the three cross-sectoral topics relevant to the industry is outlined in Figure 2.

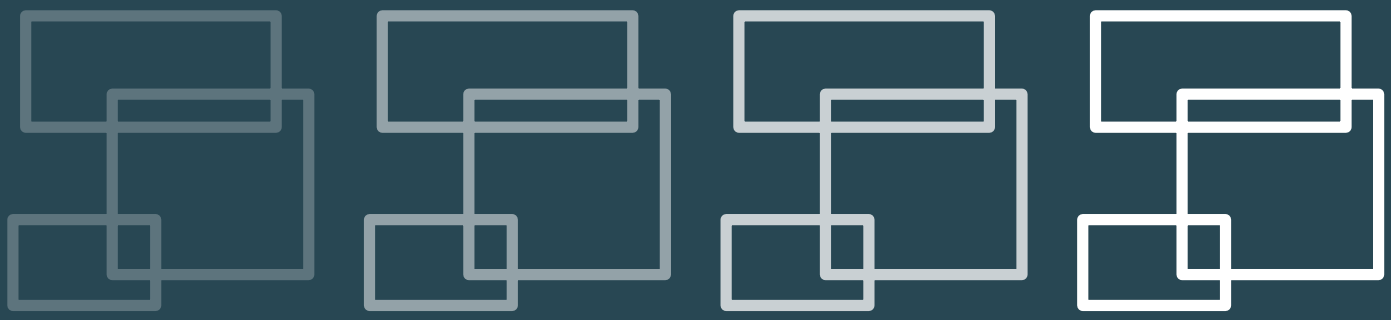
**Digital technologies** provide support in all fields of action, both in research and development and in production through to recycling and are listed in each field of action.

20 Here the concept “Real-world laboratories and test fields” is taken up with the same intention as presented in the innovation strategy innoBB 2025 plus, Regional Innovation Strategy of the State of Brandenburg, published in June 2019.

21 The federal programmes, in particular the Federal Broadband Expansion Programme of the Federal Ministry of Transport and Digital Infrastructure (BMVI), pursue network expansion. Brandenburg has laid the foundation for the expansion of a gigabit network with the state development programme “Brandenburg Glasfaser 2020”. https://mwe.brandenburg.de/de/brandenburg-treibt-den-breitbandausbau-voran/bb1.c.478824.de, accessed 26/09/2019.

| | I. Sustainable speciality chemicals | II. Sustainable plastics industry | III. Plastics processing and lightweight construction technologies |
|---|---|---|---|
| | • Expansion of bio-based value creation systems<br>• Further development of bio- and process technologies, utilisation of interfacial processes and catalysis<br>• Battery chemicals and electrochemical conversion<br>• Chemical design for heat storage materials<br>• Digitalisation of production and distribution processes | • Establishing a recycling economy for plastic materials<br>• Biopolymers<br>• Functional integration<br>• Additive manufacturing<br>• Digitalisation of production and distribution processes | • Developing sustainable lightweight construction materials<br>• Function-integrative lightweight design<br>• Multi-material design<br>• Economic and energy-efficient manufacturing technologies<br>• Additive manufacturing<br>• Reusing and recycling<br>• Material characterisation and material models of lightweight construction materials and semi-finished products<br>• Lightweight design in the construction industry<br>• Digitalisation of production and distribution processes |
| **IV. Securing skilled employees** | • Career and study guidance<br>• Initial and continuing vocational education and training | • University education<br>• Training management personnel | |
| **V. Sites and logistics** | • Funding the further development of plastics and chemistry locations<br>• Internationalising to support location development | • Improving logistic links for the locations<br>• Brandenburg's location advantages for the economic use of renewable energies | |
| **VI. Markets and technologies** | • Identifying and exploring topics of the future via market observation and technology analysis<br>• Identifying cross-cluster potential<br>• Communicating the cluster's potential for providing solutions to questions of sustainability | | |

Figure 2: Overview of the fields of action in the Cluster Plastics and Chemistry



# 4 Fields of action

# 4 Fields of action

## 4.1 Specialist fields of action

The sustainability requirement runs like a red thread through the entire Master Plan of the Cluster Plastics and Chemistry. In addition to the sustainable management of fossil-based resources, the production, use and cycle-oriented recycling of bio-based substances and materials is being further developed in the interests of a sustainable bioeconomy. As a result, the focus is now more than ever on greenhouse gas reduction, recycling, recyclability and sustainable bioeconomy. Technologically, the objectives and tasks of sustainability are particularly visible in the specialist fields of action.

The goal of the ecologically sustainable further development of the Cluster is to achieve climate and resource neutrality. This goal applies to all stages of the value chain and all phases of the product life cycle. In the fields of action “Sustainable speciality chemicals” and “Sustainable plastics industry”, solutions are required for a gradual transformation from the use of fossil resources to the use of regenerative or recyclable resources with the aim of closing material cycles in this way. Here it must be considered that the development of innovative products sometimes creates other problems (e.g. environmental or health problems during disposal). Particularly in the fields of action “Sustainable plastics industry” and “Plastics processing and lightweight construction technologies”, suitable disposal concepts must therefore be included as early as the product development stage.

The term “sustainability” refers to the interaction of ecological aspects in a stringent combination with economic and social objectives. According to this view, innovations based purely on ecological considerations will have no effect without economic implementation. A positive contribution on the part of the solution providers is also required, so that acceptance and participation by the general public and employees can be achieved.

The following section describes the fields of action in terms of their specific characteristics for Brandenburg, identifies the strategic goals of the Cluster players and examines particular subtopics in greater detail.


Figure 3: Model of the circular economy, source: European Parliament Press Service

### 4.1.1 Sustainable speciality chemicals

The originally defined task of bio-based speciality chemicals is extended by additional sustainability aspects of recycling management and bioeconomy. The focus remains primarily on the further processing of bio-based primary raw materials, residual materials and by-products such as wood, straw, oil plants and biogenic waste, e.g. landscape management material[22], etc., into intermediate products for high-quality applications. Substituting fossil raw material sources with alternative, bio-based raw materials in line with the sustainability strategy of the State of Brandenburg and the bioeconomy strategy of the federal government makes it possible to exploit important sustainability potential.

Scientific competencies in Brandenburg are provided by the Leibniz Institute for Agricultural Engineering and Bioeconomy e. V. (ATB), the Fraunhofer Institute for Applied Polymer Research IAP and the Eberswalde University for Sustainable Development HNEE. On the industry side, large companies, established medium-sized businesses and start-ups are represented. For example, BASF Schwarzheide GmbH, IOI Oleo GmbH, GREIBO Chemie GmbH, Prefere Resins Germany GmbH and LXP Group GmbH are involved in the

22 Potential study “Landscape management material in the State of Brandenburg” by the Ministry of Rural Development, Environment and Agriculture (MLUL), 28/11/2014.

Cluster Plastics and Chemistry on issues relating to sustainable, in particular bio-based speciality chemicals.

In order not to compete with the food industry, preference is given to second-generation processes, i.e. biomass residues and plant components[23] or crops that are not suitable as food. The challenge is to recycle both substance groups, i.e. sugar and lignin components, since they are continuously produced as co-products in a fixed quantity ratio. Where possible and reasonable, the cascade and coupled use of biomass should be established. Utilisation cascades and intelligent linking of value and process chains can improve resource efficiency, defuse possible competition between utilisation paths and open up innovation potential.[24] In addition to the biogenic origin of the starting materials, the focus is on

- the sustainable **production** and processing of speciality chemicals with the aim of reducing greenhouse gases and increasing resource efficiency
- sustainable **use**, i.e. excluding risks to humans and animals and ensuring environmental compatibility, especially for water and air quality
- the **collection** and **recycling** of used chemicals into the material cycle, as well as **biodegradability**

The development of new process technologies requires longer periods of time. Verifying a process modelled in the laboratory in a pilot plant usually takes several years. Further scale-up to an industrial scale requires additional time and investments, which are only made on the basis of a realistic profitability outlook. First successes were recorded in the fields of bioethanol and lactic acid production.[25] Here it is important to pursue the adopted technology paths and at the same time to develop the customer markets for the chemical intermediates in a targeted manner. The prerequisite for this is security of supply and a guarantee of consistent material qualities of the biogenic raw materials.

The sustainable substitution of fossil-based raw materials with renewable ones requires the durability and performative properties of the materials to be maintained.

The following **strategic objectives** are pursued in the field of action “Sustainable speciality chemicals”:

- Development and scaling-up of sustainable value-added systems for bio-based and biodegradable products and intermediates through process development measures that successively build on each other – development of a market for commercially successful use through cascade use of biogenic starting materials in Brandenburg
- Further development of bio- and process technologies and technology transfer for commercial implementation and securing the future
- Development and economic realisation of material systems for a sustainable energy supply and mobility
- Strengthening of the Cluster players with regard to the establishment and optimisation of digitally supported processes to improve competitiveness
- Consolidation and intensification of network formation to harness synergies within the field of action, with other fields of action in the Cluster and with economic partners and customers of other clusters

23 e.g. leaves, peels, stalks and tree trunks

24 Cf. Federal Ministry of Food and Agriculture (BMEL): Nationale Politikstrategie Bioökonomie [National Bioeconomy Policy Strategy], p. 21, 2014.

25 The Leibniz Institute for Agricultural Engineering and Bioeconomy e. V. (ATB) with an implemented pilot plant for the production of bio-based products (e.g. lactic acid), https://www.atb-potsdam.de/institut/ueber-uns/forschungsinfrastruktur/pilotanlage-milchsaeure.html, LXP Group with a new digestion process for the lactic acid fermentation of lignocellulose from plant residues, https://nachhaltigheute.de/innovationen/biomasse-zu-kunststoff, accessed 12/12/2019.

The following exemplary topics describe opportunities and potential for Brandenburg's players and indicate particular key focal points for action.

### Expansion of bio-based value creation systems

The challenges in the development of bio-based processes for speciality chemicals are to increase the efficiency of chemical/biotechnological processes, **to provide the biogenic raw materials in the right quantities** (input) and to **develop the market** for the quantities produced (output).[26] The latter can represent an insurmountable hurdle for individual companies, especially if they want to enter the market as a start-up with a new process, or if they do not yet have sufficient market strength as a medium-sized company. On the other hand, buyers of a biogenic intermediate product do not want to make themselves dependent on a single supply source and are looking for alternative procurement options. Here the demand for coordinated action of the players in the industry and in the state with regard to the standardisation of requirements and necessary material properties becomes apparent and also requires integration at European level.

In order to **achieve** the **necessary critical quantity of materials** for the establishment of bio-based value-added systems, suitable players must be interested in the specific material flows and material classes (families of molecules) in Brandenburg and brought together as potential partners. The future interaction can, for example, be designed as a **real-world laboratory** in which identified research and development tasks can be coordinated and the necessary investments can be supported. If necessary, legal frameworks can also be tested and adapted and additional competence partners can be brought in nationally or internationally. Integration with initiatives of other European regions (e.g. the bioeconomy pilot of the Vanguard initiative) could also be useful here. When developing the new processes, a consistent **life cycle assessment** with regard to sustainability effects must be proactively implemented from the very beginning. The results and progress achieved here can be used to inform the public and recruit additional suitable personnel.

### Further development of bio- and process technologies, utilisation of interface processes and catalysis

Efficient processes of **bio- and process technologies** to close the material cycle have developed dynamically in recent years against the background of sustainability goals. **Interfacial processes** play a decisive role in this. Scientists at the Brandenburg University of Technology Cottbus-Senftenberg are making an essential contribution with exploratory work on the rational design of carbon-based catalysts. In addition to industrial and biotechnological processes, functional surfaces with special catalytic activity also enable the conversion of electrical to chemical energy within fuel/electrolysis cells and batteries. As a result, they play a key role in the energy transition.

In addition to the development of new catalysts and functional surfaces, the **durability** and **recycling** of catalysts is a crucial aspect. Especially the recovery of minute amounts of precious metals from the surfaces of spent catalytic converters, e.g. of passenger cars or fuel cells, is a challenge for technology and analytics.

The use of **biocatalysts** (enzymes, bacteria, yeasts) for the selective transformation of organic substances represents an ecologically advantageous alternative to conventional processes. A long-term or at least repeated use of the mostly cost-intensive, poorly available enzymes can only be achieved by **immobilisation** on stable carrier materials. The challenge here is, among other things, to maintain the functionality of the enzyme despite fixation. This is particularly important during the transition from laboratory to technical or industrial scale and can be satisfactorily solved by comprehensive basic and applied research.

The use of biocatalysts in industrial processes is still relatively recent in many disciplines. In Brandenburg, a number

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26 e.g. products of the sugar platform or aromatics for applications from bioplastics to road construction, cosmetics/skin care or a photoresist

of research institutes have been working on bioeconomy issues for several years, such as the Institute of Biotechnology at the Brandenburg University of Technology Cottbus-Senftenberg and the Department of Molecular Biotechnology and Functional Genomics at Wildau Technical University of Applied Sciences. A project group of the Fraunhofer Institute for Applied Polymer Research IAP and the Brandenburg University of Technology Cottbus-Senftenberg, together with companies from the region, is researching **methods of functionalising polymer and biopolymer materials**. Of particular interest are applications in diagnostics, the synthesis of speciality chemicals and pharmaceuticals as well as in environmentally relevant fields such as waste water treatment. With their research activities, these institutions provide the basis for the settlement or establishment of innovative companies (e.g. attomol GmbH Bronkow, GA Generic Assays GmbH Dahlewitz, GICON Advanced Environmental Technologies GmbH Cottbus, Carbon Biotech AG Senftenberg).

This illustrates the close topical links with other sectors such as the health and food industry and environmental technology. The Leibniz Institute for Agricultural Engineering and Bioeconomy e. V. (ATB) is one of the institutions active at the interface of technical and biological systems. The ATB researches and develops new technologies and strategies for the site-specific production of biomass and its use for food, as bio-based materials and fuels.[27]

The aim of the further development of bio- and process technologies is to **network the relevant players** so that the reconciliation of interests and exchange of experience stimulates application development and process optimisation, leading to new initiatives. The field of bio- and process technologies also represents an opportunity for start-ups and company settlements. To this end, already established project groups such as the "Biofunctionalisation/Biologisation of Polymer Materials BioPol" project group should continue to be supported and expanded.

### Battery chemicals and electrochemical conversion

In the context of the energy and mobility transition, topics such as energy storage materials in general and **battery chemicals** in particular are becoming increasingly important. The focus is on sustainability issues in the production and recycling of battery materials, as well as the recycling of metallic and graphite-containing electrode materials.

In this area, a number of smaller companies in Brandenburg and Saxony are active in the recycling and recovery of battery materials. A series of nationally funded projects[28] are currently underway in cooperation with the Department of Physical Chemistry of the Brandenburg University of Technology Cottbus-Senftenberg, which focus on the recovery of battery materials from spent batteries at a specially constructed pilot plant. Building on existing expertise, the recycling of lithium-ion batteries in particular can play an important role in structural change in the Lusatia region.[29]

The **$H_2$ economy** (or **$CO_2$ capture** processes) represents another development area where energy technology and mobility are being developed together. The $H_2$ storage technology and the required containers are attributed a central role in the further implementation of renewable energy production. The ability to temporarily store surplus electricity for low-yield periods is a key to increasing the base load capacity of volatile power generation and therefore a central component of the energy transition. The stored hydrogen can be used to generate electricity or can be used as a fuel or as a basic material for chemical processes. $CO_2$ can also be used as a raw material for other industrial fields outside the energy industry, e.g. in the production of biomass (algae production) or in gas fermentation.

The overarching tasks of the energy and mobility transition require an intensification of networking between industry and research in the participating sectors and clusters. **Integration into national and European programmes and initiatives** plays an increasingly important role in this respect.

27 https://www.atb-potsdam.de/nc/institut/ueber-uns/start.html, accessed 26/09/2019.

28 New process for the non-destructive recovery of cathode material from lithium-ion batteries without quality degradation, https://www.b-tu.de/news/artikel/15423-neues-verfahren-zur-zerstoerungsfreien-rueckgewinnung-vo, accessed 11/09/2019.

29 A current survey, the long version of which was published by the Otto Brenner Foundation in November 2019, confirms that Lusatia, with its existing industrial structure and research facilities, has enormous potential as a location for technologies for recycling lithium-ion batteries. In order to strengthen this regional strategy, the existing coordinating activities stemming from the Department of Physical Chemistry of the Brandenburg University of Technology Cottbus-Senftenberg are to be continued, as are the further networking and coordination of local activities and their integration into supra-regional networks. G. Holst, K. Nicke: "Arbeits- und beschäftigungsorientierte Entwicklungsstrategie: Batterierecycling als industrielle Perspektive für die Lausitz" ["Employment-oriented development strategy: Battery recycling as an industrial perspective for Lusatia"], summary of the study by the IMU Institute and Ludwig-Bölkow-Systemtechnik, 2019.

The cooperation in project networks, especially by utilising specific regional location advantages, can be intensified by the organisation with real-world laboratories and test fields and can be supported effectively with regard to the market ramp-up. The resulting visibility can in turn stimulate qualification offers and indirectly lead to new research areas.

### Chemical design for heat storage materials

The coal phase-out will lead to a noticeable restructuring of the energy supply in the State of Brandenburg. Compensation for the temporal and possibly local fluctuations between energy supply and demand when using regenerative sources requires a significantly greater use of energy **storage media**. However, currently about 33% of the energy requirement is already being used for **thermal applications**; industry needs another 21% for process heat.[30] Under technological and economic aspects, the use of thermal storage therefore offers the greatest savings potential for the use of primary energy. A combination of heat storage tanks and pumps could enable waste heat flows to be recycled sensibly in the future. High storage densities within small temperature ranges mean that latent heat storage materials and systems are particularly suitable for such applications.

This research topic is already present in companies in Brandenburg[31], even if so far only in the evaluation phase. In contrast, exploratory work at universities and research institutes is already underway at a high level. For example, the Department of Inorganic Chemistry of the Brandenburg University of Technology Cottbus-Senftenberg coordinates a national project network in the 6th Energy Research Programme of the federal government.

The status of the development work is to be made available to interested companies through an increased **knowledge and technology transfer**. Together with potential partners from industry, the individual requirements for the respective storage systems must be formulated and suitable implementation paths selected.

### Digitalisation of processes in production and distribution

Even though processes in the chemical industry are generally controlled, the need for digitalisation in the companies of the Cluster Plastics and Chemistry is still believed to be high. The following are given as motives for digitalisation (the order in which they are mentioned reflects the frequency of the statements from the company survey[32]):

- Improvement or simplification of **work processes**
- Improvement of **cost efficiency** through new equipment and working tools
- Improvement of the **quality of products** or **services**
- **Growth**, opening up **new markets** or introducing **new business models**
- **Requirements** of customers, suppliers or competitors

Companies report different starting points for digitalisation. Special effects are expected from better networking of technical control systems at plant level with administrative systems at management level. Here, companies can be inspired by best practice examples of similarly structured companies and effectively supported with the information and support services already available in Brandenburg. When introducing new technical systems and changes to operational processes, it is above all the employees who must be included in good time through the company co-determination bodies. Digital change must always be tied in with the associated training of employees.

Brandenburg offers a wide range of support services from specialised solution providers and consultants, as well as appropriate professional training and continuing training formats from universities, training providers and chambers. Competence centres and special funding programmes have been set up specifically to support companies in planning

30 Final energy consumption by application areas, source Federal Ministry for Economic Affairs and Energy (BMWi): Energieeffizienz in Zahlen – Entwicklungen und Trends in Deutschland 2018 [Energy efficiency in figures. Developments and trends in Germany], p. 21.

31 In cooperation with Saxony.

32 In a company survey carried out in 2017 on the status of digitalisation among 1,051 companies in Brandenburg, 51% of the surveyed companies in the chemical, pharmaceutical and plastics industries do not yet consider themselves sufficiently digitally networked. Source: Project “Arbeit 4.0 in Brandenburg – Digitalisierungsprozesse in ausgewählten Bereichen der Brandenburger Wirtschaft und deren Auswirkung auf die Organisation und Gestaltung von Arbeit” [“Work 4.0 in Brandenburg – Digitalisation processes in selected areas of Brandenburg’s economy and their effects on the organisation and design of work”], June 2018.

and implementing digitalisation projects. Examples include the Brandenburg Innovation Centre for Modern Industry[33] and the SME 4.0 Competence Centre[34] with special offers for vocational qualification as well as "Digitalwerk"[35], the Centre for Digitalisation in Crafts and SMEs.

### 4.1.2 Sustainable plastics industry

The field of action "Sustainable plastics industry" has developed from the previously established field of action "Biopolymers" with a focus on the use of biogenic raw materials for the production of plastics. In recent years, the **concept of sustainability** has been extended to other areas of the plastics industry. Global problems of waste disposal and environmental pollution caused by packaging plastics have intensified the social and consequently also the political discourse[36] on the subject. In combination with the perceived climate effects, recycling strategies for waste reduction and $CO_2$ emission savings are therefore also becoming increasingly important for Brandenburg companies.

As a result, the focus extends from the upgrading of **sustainable (biogenic) raw materials** for the plastics industry to include topics such as

- the **recyclable design** of plastic components,
- the sustainable, i.e. material- and energy-efficient **production** of plastic material and its **processing**,
- the sustainable use, **reuse** and **repair** of plastic products,
- the quality-conserving **collection** and **recycling** of plastics,
- the transformation to a sustainable plastics industry by increasing the use of recycled and bio-based plastics.

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Another field of research is the **"biologisation" of plastics**. The university and research locations of Potsdam-Golm, Senftenberg and Wildau have developed special scientific competencies that are networked beyond the region. In this new field of research, the surface and/or volume of plastic components and semi-finished products are modified using biological functional elements. This opens up new application and product possibilities, e.g. in medicine (bioanalytics) or in transportation (antimicrobial surfaces).

The plastics industry includes the production of materials, the development of new materials with special properties and the processing of these materials into components and products made of plastic. Brandenburg is home to around 80 manufacturers and processors of thermoplastics (consumer goods, packaging, automotive, electrical and construction industries), thermosets (special applications, temperature resistance) and elastomers (rubber and tyre industry).[37] The economic interdependencies result in close ties with the speciality chemicals industry as a supplier of raw materials and the application sectors, such as the construction industry, the automotive industry and the health and food industry.

33 The Brandenburg Innovation Centre for Modern Industry, funded by the State of Brandenburg, is located at the Chair of Automation Technology at the Brandenburg University of Technology Cottbus-Senftenberg, https://www.imi4bb.de/, accessed 11/09/2019.

34 The Cottbus SME 4.0 Competence Centre, funded by the BMWi, supports small and medium-sized companies in Brandenburg with regard to the increasing changes in the world of work and the resulting training measures. https://www.kompetenzzentrum-cottbus.digital/, accessed 11/09/2019.

35 The "Digitalwerk", funded by the State of Brandenburg, also offers free support for small and medium-sized companies in the State of Brandenburg for digitalisation projects. https://digital-werk.org/, accessed 11/09/2019.

36 European Commission: "A European Strategy for Plastics in a Circular Economy", Brussels, 16/01/2018.

37 Establishments with 20 or more employees; source: Office for Statistics Berlin-Brandenburg [2019]: Statistical report E I 1 - j/18. Manufacturing industry in the State of Brandenburg Year 2018.

The following **strategic objectives** are being pursued to strengthen a sustainable plastics industry:

- Supporting measures and projects for the development of sustainable value-added systems for bio-based plastics, taking into account the entire product life cycle – also using opportunities for participation in shaping the framework
- Supporting the further development of processes and material flows in the plastics industry towards a sustainable circular economy
- Highlighting the pooling and expansion of research capacities for the technological development of new applications of polymer materials and mechanisms of function integration up to their industrial implementation – this also includes additive manufacturing processes
- Indicating the potential of digitally supported processes to improve sustainability and competitiveness, especially in manufacturing and sales
- Supporting measures for the consolidation and intensification of network formation to harness synergies within the field of action, with other fields of action in the Cluster and with economic partners and customers of other clusters

### Establishment of a circular economy for plastic materials

Plastic has become indispensable in many areas of our lives. After use, the question arises of how to reduce residual waste, protect the environment and preserve the raw materials which plastic contains. The solution is to establish **closed material cycles**. For plastics, the circular economy represents both a challenge and a way forward. Here, technological and organisational tasks have to be managed simultaneously in several areas, which requires cooperation between the value-adding partners involved as well as the public. Information and communication must therefore involve all players and, as far as possible, a wider public. In Brandenburg, there are both manufacturers of recycling material (such as ALBA Recycling GmbH in Eisenhüttenstadt and Remondis Brandenburg GmbH in Brandenburg an der Havel) and plastics processors (such as Gefinex GmbH in Pritzwalk, ESE GmbH in Neuruppin, SWK Innovations GmbH & Co. KG in Lübbenau, Kunststoffverarbeitungs GmbH in Falkensee and the fibre manufacturer Trevira GmbH in Guben), which are working on the upgrading of recycled materials. Scientific partners such as the Fraunhofer Institute for Applied Polymer Research IAP in Potsdam support the players with applied research aimed at industrial application. Further players are being sought in order to ideally close value chains regionally.

Organisational and technical challenges include:

- Improving the **efficiency of the collection processes**: For example, production waste (trimmings, cast slugs) can already be collected for recycling during production.
- Further development of **separation technology processes**: The quality properties of the recycled material are directly influenced by the purity of the material used. The task is to reliably detect and remove impurities in the waste, especially plastics with other molecular components, e.g. silicones, from the material mix. Sensor and actuator systems from Industry 4.0 can provide cost-effective solutions here. From a technological point of view, for example, it may be advisable to upgrade existing systems with white light or NIR[38]-based flake sorters in order to further increase the sorting quality.
- **Recyclable design:** The repairability, in the sense of the longevity of the products, as well as the recyclability are predetermined by design and construction. Relevant research institutes can provide support here by developing design methods and concepts, as well as targeted awards such as prizes[39] or seals of approval from relevant associations, in order to make recyclable products more visible.
- Likewise, measures to **standardise recycling processes** are considered promising with a view to making the value-added system transparent for other players by means of defined interfaces between the processes. This will also make it easier to determine quality

38 Spectrometer in near infrared light for fast material identification.

39 Brandenburg Innovation Prize for Plastics and Chemistry, https://innovationspreis.kunststoffe-chemie-brandenburg.de/, accessed 10/09/2019.

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standards for recycled materials, which will help to promote their wider use in plastics processing.

- Where it is no longer economically feasible to separate the plastic material from other residual materials, **chemical recycling** processes are a good option, i.e. chemical splitting of mixed plastic fractions into monomers as starting materials for the chemical industry.

- As the final recovery stage, **thermal utilisation as a secondary fuel** is still an option in order to provide the required process heat through the energy content of the residual materials. In general, **material recycling** in the form of cascade use is **preferable** to energy recycling.

A special research and development topic arises from the **challenge posed by microplastics**. Due to the complexity of modern supply chains, the cause of the occurrence of microplastics, e.g. through tyre abrasion, textile fibre abrasion, cosmetic products, etc., cannot currently be unequivocally attributed to individual countries and industries. Nevertheless, it is a far-reaching and global problem for which solutions must be sought more intensively in cooperation with players at international level. For example, solutions with biopolymers and renewable raw materials are already being developed in the cosmetics industry in order to minimise the proportion of microplastics.[40]

The medium-term goal of the Cluster for Brandenburg is therefore to implement **circular value chains** in the plastics industry on the basis of selected **pilot processes** (e.g. defined by material and application groups). A first step towards this is the exchange between the value-adding partners with the aim of jointly developing **standardised product properties** and, in a second step, refining the materials for this purpose. A circular economy is therefore also a communication task, which must be carried out both by the Cluster and by the associations and networks active in the plastics industry.

Likewise, the expansion of **qualification offers** at universities and vocational training institutions as well as the support of general and vocational schools to **sensitise young people** for future roles in the recycling industry and as consumers must be tackled as a joint task. A **future-oriented vocational education** for the plastics industry at technical colleges and universities is an important prerequisite for the establishment of a sustainable plastics industry in Brandenburg.

The expansion of plastic recycling activities could also be organised in the form of real-world laboratories. Here, the quantity and processing volumes of the three pillars – material sources, recycling process and utilisation of the recyclate – must be developed synchronously in the value-added system. At the same time, the existing legal framework of waste management for simplified and economic handling of residual materials could be optimised and evaluated.

### Biopolymers

The development of polymers without the use of petroleum-based raw materials is the initial development core of the field of action “Sustainable plastics industry”. Brandenburg, as a federal state with a distinctive forestry and agricultural industry, lends itself to the development of biogenic plastic materials. **Scientific expertise** in this area has advanced in recent years. Particularly noteworthy are the Fraunhofer Institute for Applied Polymer Research IAP, the Leibniz Institute for Agricultural Engineering and Bioeconomy ATB and the Eberswalde University for Sustainable Development HNEE. With the support of the Ministry of Science, Research and Culture, a special professorship was created in 2016 for the new field of “Biopolymers and Plastics Processing” at the Brandenburg University of Technology Cottbus-Senftenberg in cooperation with the IAP.[41] There, mechanical engineering students learn about the properties of the different biopolymers, in particular their suitability for use in different

40 e.g. in so-called rinse-off products (cosmetics, cleaning and personal care products)

41 Prof. Dr. Johannes Ganster: “Plaste und Elaste aus nachwachsenden Rohstoffen – Vision, Phantasterei oder Realität?” [“Plastics from renewables – vision, pipe dream or reality?”], inaugural lecture, 21 April 2017.

processes and their biodegradability. **The companies** have developed well in recent years, from basic materials production to consumer products. LXP Group GmbH, for example, has realised a pilot plant for the economic production of biopolymers from cellulose-containing residues from agriculture and forestry. Other start-ups and company foundations in Brandenburg are concerned with the production of toys, hygiene articles, films for the agricultural and construction industries and packaging made of biopolymers.

Both the economic efficiency and the framework for the production and processing of biopolymers in Brandenburg still need to be improved. The challenge of the **industrialisation** of biopolymers lies in the simultaneous development of the availability of starting materials, the process development of biogenic materials and the application development for products made of biopolymers. Process development is only pursued with a commercial perspective if plastics manufacturers and processors offer the prospect of economically interesting purchase quantities. These must be successfully placed on the market. This is why the **value chains** should be **considered** beginning with the **customer**. The resulting cross-sectoral task is therefore an **information** and **communication task** for solutions and products made from biopolymers, addressed to customers and all potential partners in the corresponding value chains.

In order to be able to present biogenic production economically, the Cluster aims to promote an appropriate **framework**.

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Competitive energy prices, especially for electricity from renewable sources, as well as the determination of the carbon footprint of biogenic materials and their processing in connection with the implementation of $CO_2$ certificate trading provide a necessary calculation basis for entrepreneurs and investors.

The **material cycle** is closed when the components and products made of biopolymers are collected after the utilisation phase and reprocessed or recycled. A particular challenge in recycling is the material-specific sorting of the individual material groups. Alternatively, chemical and biological recycling methods can be used. In this regard, there is still a fundamental need for research into biodegradability and accelerated compostability.

In Brandenburg, the **resulting initiatives should therefore be developed further**, such as the Fraunhofer Processing Pilot Plant for Biopolymers Schwarzheide. At the Processing Pilot Plant for Biopolymers Schwarzheide, marketable and new bio-based plastics are being developed and tested using industrial equipment. In cooperation with local and supra-regional network structures, small and medium-sized plastics processing companies will also be supported in introducing bio-based plastics into production processes. In this context, the support of regional and supra-regional biopolymer networks, such as the Kunststoff-Verbund Brandenburg Berlin e. V. (Plastics Association of Brandenburg Berlin, KuVBB)[42] and the Innovation Centre Bioplastics Lausitz (IZBL)[43], is also relevant. They are available as nuclei for the compilation of innovation approaches from the regions and can support selected project approaches with partners from industry and science.

### Functional integration

The integration of several functions into a single component is a major reason for the use of plastics. **Mechatronic**, **electronic** and **optical properties** can today be **cost-effectively integrated** into plastic structures, e.g. in the form of sensors, conductor paths and actuators. With the support of the Ministry of Science, Research and Culture, the **High-Performance Centre "Integration of Biological and Physical-Chemical Material Functions"** was established at the Fraunhofer IAP for this purpose. The High-Performance Centre pools the activities of the participating private

42 Kunststoff-Verbund Brandenburg Berlin e. V. (KuVBB), Network for plastics – chemistry – biopolymers, https://kuvbb.de/.
43 Innovationszentrum Bioplastics Lausitz, https://www.bioplastics-lausitz.de/.

and publicly financed players in the Brandenburg-Berlin region, from application-oriented basic research to applied research and concrete prototype and product development. An intensive transfer of knowledge and technology to the commercial sector is also planned. Furthermore, the technology field of **biofunctionalised plastics** offers a wide range of potential applications in speciality chemistry, biology, pharmaceutics and even waste water treatment.[44]

In order to effectively support and network the players, the focus is on the **provision of structured information** with regard to **application specifics** (purpose, type and quality requirements of the properties to be integrated) and **solution principles** (effect, method, manufacturing process, provider). Questions of repair, disassembly and recycling must also be taken into account as early as the conception of the functional integration.

In this context, it is initially appropriate to continue to support and further develop the already established service centres and project groups such as the High-Performance Centre “Integration of Biological and Physical-Chemical Material Functions” and the project group “Biofunctionalisation/ Biologisation of Polymer Materials BioPol” of the Fraunhofer IAP at the Senftenberg site of the Brandenburg University of Technology Cottbus-Senftenberg.

### Additive manufacturing

With additive manufacturing processes, the desired functional integration can be focused exactly where it is needed in the component. The efficiency in terms of material usage and the assembly times promise better cost-effectiveness in the medium term compared to conventional manufacturing processes. However, the still high cycle times are an obstacle to cost-effective series production. Process optimisation and material development are closely interconnected in the further development of biogenic plastic materials, especially in application development.

Additive manufacturing makes completely new assembly concepts possible, as the design can now be based on requirements rather than production constraints. As early as ten years ago, the Panta Rhei lightweight construction centre of the Brandenburg University of Technology Cottbus-Senftenberg began to explore the potential of 3D printers for plastics and metals. Promising applications are currently seen, for instance, in the application of electrically conductive or optically active materials. Automated fibre placement (AFP) represents a new area of additive manufacturing. This process is used in the Chair of Polymer-based Lightweight Design at the Brandenburg University of Technology Cottbus-Senftenberg to lay down fibre-reinforced tapes in several layers and thus in a three-dimensional load path.

As the processes are both comprehensible and attractive, the development of **“3D printing”** didactic modules is ideally suited for use as teaching materials in schools and for teacher training. Correspondingly, application and demonstration laboratories for additive manufacturing at university campuses in cooperation with engineering and design courses and at technology centres should be increasingly supported and expanded.

### Digitalisation of processes in production and distribution

In the plastics industry, digitalisation can effectively support technical and non-technical innovations and in some cases only makes them possible in the first place. The following exemplary list of digital tools in the product life cycle illustrates the potential offered by the selective use of digital systems.

Material development itself can already be implemented more effectively and faster with digitally supported test planning. New product concepts and designs are nowadays usually created with the help of digital design and construction tools. By means of special interface design and kinematics tools, realistic images and functionalities can be exchanged with potential customers and users and acceptance can be verified.

A broad field, especially in combination with the demands for material and energy efficiency, is the field of manufacturing: There are many possible applications for digitalisation, from process monitoring, machine and system control and monitoring to integrated quality assurance. The urgent focus here is not always on the complete digitalisation of all operations and sensors. Rather, the aim should be a purpose-related, process-accompanying recording of particularly relevant conditions with regard to quality, cost-effectiveness and sustainability. Manufacturing, assembly and handling technology can be optimised effectively and efficiently with digitally supported tools for production and factory planning. Digitised order management, coupled with logistics and supply

44 Cf. field of action “Sustainable speciality chemicals”.

chain functions, ensures cost-effective production, embedded in the necessary movements of goods in the supply chain. Here, additional efficiency potentials can be realised in particular by networking administrative systems with production technology systems.

On the way to the customer, digital platforms (business-to-business platforms) can increase the efficiency of the ordering process and, if necessary, be supplemented with further information on the future demand profile. Particularly when operational processes and professional activities are being converted, employees must be involved directly or via company co-determination bodies. The reorientation of occupational profiles and the adaptation of apprenticeship professions in the industry are also necessary steps that involve the digitalisation of processes.

Further topics of digitalisation in the circular economy are expected to include an increase in the transparency of material cycles and traceability. Communication and public relations increasingly take place via digital platforms and social networks.

The individual conversations and discussions from the participation workshops show a varying level of demand for digital solutions. **Company-specific information and support services are required** here. The task is to network those seeking solutions with the solution providers and to facilitate an exchange of best practice. In this context, the strengthening of research, testing and qualification facilities at Brandenburg's university and research locations should also be continued.

### 4.1.3 Plastics processing and lightweight construction technologies

Lightweight construction is per se a sustainable key technology for addressing current challenges. Consuming less material and using it in both stationary and mobile applications contribute to resource and energy efficiency, both in the manufacture and operation of components.[45] There are sustainability challenges in the production and processing of lightweight as well as composite materials, in plastics processing and especially in material recycling. An important goal with regard to reuse and recycling is a repair-friendly or recyclable design of the lightweight structures.

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Lightweight construction is in demand today in almost all industrial sectors. For some years now, lightweight construction solutions have also found their way into the construction industry. Activities relating to electromobility and the energy transition will be particularly in the spotlight, as great potential for science and industry is emerging in these areas. The now high acceptance of and demand for lightweight construction solutions has meant that a large number of industrial projects have been initiated and successfully completed on the basis of the expertise offered by the scientific competence centres in Brandenburg.[46]

As early as 2014, the expansion of competence for new sustainable products was set as a strategic objective. This was implemented with the establishment of the competence centre for energy- and resource-efficient lightweight construction in Wildau in cooperation with all the universities and research institutes in Brandenburg relevant to lightweight construction. The Fraunhofer IAP's research department for polymer materials and composite PYCO, the Brandenburg University of Technology Cottbus-Senftenberg, Wildau Technical University of Applied Sciences and the Eberswalde University for Sustainable Development work together in the competence centre.

45 Cf. coalition agreement of the Federal Government between CDU, CSU and SPD, 07/02/2018, p. 58, https://www.bundesregierung.de/breg-de/themen/koalitionsvertrag-zwischen-cdu-csu-und-spd-195906, accessed 20/12/2019.

46 In the field of lightweight construction/composite materials, around 20 new projects were initiated in 2017 and 2018 respectively, the majority of them industrial projects. Source: Ramboll: "Jahresbericht 2018 zum Ergebnis- und Wirkungsmonitoring – Cluster Kunststoffe und Chemie Brandenburg" ["2018 Annual Report on Results and Effects Monitoring – Cluster Plastics and Chemistry Brandenburg"].

Companies based in Brandenburg are also included, such as Rolls-Royce Deutschland Ltd. KG, Forster System-Montage-Technik GmbH, Prefere Resins Germany GmbH, Motzener Kunststoff- und Gummiverarbeitung GmbH, Trevira GmbH and Lausitzer Klärtechnik GmbH. At the Panta Rhei Research Centre for Lightweight Materials at the Brandenburg University of Technology Cottbus-Senftenberg, industrial projects are carried out with regional and international partners.

The process of competence development and pooling of resources at both locations of the Brandenburg University of Technology was marked by good staff networking and a high level of commitment on the part of the responsible players. This is continuously maintained and further developed through regular meetings of the players from industry and science. The close links to the respective professorial chairs and specialist areas at the universities mean that young scientists are able to find their first professional challenges for lightweight construction tasks through practical projects in the companies.

The further development of strong value chains in the areas of polymer-based lightweight construction and material combinations in the form of multi-material design are of fundamental importance, also against the background of the challenges of electric mobility. In many vehicle concepts with a special focus on energy and resource efficiency, the proportion of polymer-based components currently exceeds 30 mass percent.

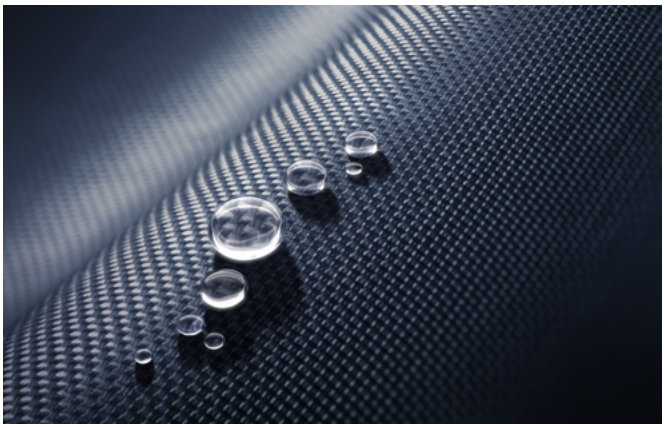
The following **strategic objectives** are pursued by the players in the field of action:

- Consolidation and expansion of value chain-oriented competencies in the design of energy-efficient lightweight construction systems as a contribution to the energy transition
- Establishment of comprehensive value chains for the production of plastic-based lightweight components for electric mobility
- Development of individualised lightweight construction solutions through the holistic digitalisation of the product creation process: material development, material and component characterisation, manufacturing technologies, design and simulation as well as evaluation in realistic test routines
- Implementation of function-integrated lightweight designs by implementing sensor and actuator functions in fibre composite components using flexible and automated manufacturing processes
- Establishment of recycling and repair-friendly design of components and assemblies
- Increasing the participation of small and medium-sized businesses in research and development projects
- Support of measures to further expand the research and qualification capacities of the cooperating universities and research institutes with the involvement of committed companies for energy- and resource-efficient lightweight construction
- Support for projects aimed at establishing university courses and other training opportunities in the fields of lightweight construction and plastics processing
- Joining forces with a view to expanding the network and initiating additional strategic alliances through cross-cluster activities and through cooperation with industry, small and medium-sized businesses as well as industry and trade associations

### Development of sustainable lightweight materials

On the initiative of the competence centre for energy- and resource-efficient lightweight construction, several projects have been and are being carried out together with industry partners with the aim of improving the sustainability of the materials and manufacturing processes used.

The development of new materials and material combinations for the energy- and resource-efficient production of vehicle components, such as structural components and energy storage systems, is of fundamental importance for the challenges of electric mobility. Development along the entire value chain – materials development, semi-finished products, production, construction and design, testing – must take place hand in hand. The targeted and process-oriented material development is made possible by the cooperation of the Brandenburg University of Technology Cottbus-Senftenberg with the PYCO research division of the Fraunhofer Institute for Applied Polymer Research IAP and Wildau Technical University of Applied Sciences.



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The PYCO research division and the Eberswalde University for Sustainable Development HNEE work together to develop **lightweight construction solutions made of wood**, or in **plastic-wood** combinations. Wood is a natural polymer which, due to its composite structures, represents an optimised ratio between directional load-bearing capacity in combination with a low specific weight. A special focus is placed on waste wood, which is available in significant quantities in the sense of "urban mining". Instead of merely recycling it thermally, new possibilities for material recycling are opening up.[47] Knowledge about the handling and use of renewable raw materials is necessary to make such recycling possible. For example, the skills for handling wood or modular timber construction must be taught and developed.

A specific but nevertheless important future topic is the **cost-effective and sustainable production of high-strength fibres**, e.g. on the basis of biopolymers or polymer fibres, and their processing into fibre-reinforced semi-finished products. Based on the established processes in the textile industry, cost-effective and resource-saving manufacturing processes for high-performance fibres for use in mixed construction methods are currently being developed in Guben and Cottbus.

### Functionally integrated lightweight construction

The integration of, for instance, **electrical** and **optical** properties in moulded and structural components can save component weight. The innovation ideas often emerge in discussions with company representatives.

With lightweight structures there is often a risk of sudden component failure. Here, integrated sensor technology as part of structural health monitoring can reliably anticipate load limits.

An important player in the field of functional integration is the Fraunhofer Institute for Applied Polymer Research IAP, which has mapped the various forms of functional integration in its research division structure and is integrated in terms of personnel with both the High-Performance Centre "Integration of Biological and Physical-Chemical Material Functions" and the competence centre for energy- and resource-efficient lightweight construction.[48] In addition to the integration of sensors and actuators, the integration of fire protection properties is of outstanding importance, especially for mobility applications.

### Multi-material design

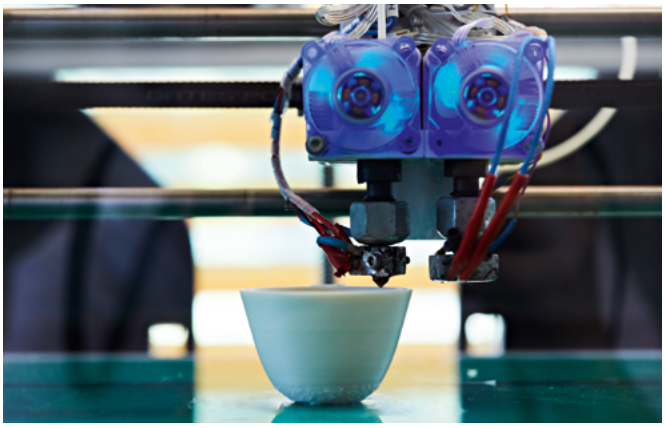
Although lightweight construction in this field of action is primarily achieved through the use of polymer materials that have to be adapted for the intended uses, multi-material construction methods in particular open up new weight-saving and application potentials by combining certain material properties. Prepregs with high-strength fibres in combination with plastic and metal components can be used to produce **high-performance components** that contribute to weight reduction and thus energy efficiency, for example in automotive engineering, energy technology or competitive sports. Alternative curing methods, e.g. with microwaves or UV radiation, offer the possibility of further processing prepregs and components in an energy- and resource-efficient manner. The combination of automated fibre placement (AFP) with steel profiles offers the possibility of automated manufacturing with a pronounced process stability, and represents a special form of multi-material design.

The technical application of components made of metal-plastic combinations and fibre composite components requires the reliable joining of the different materials by means of special joining technologies. The aerospace industry in particular places extreme demands on mechanical and thermal[49] properties.

47 If wood is used as a single material, there are no particular difficulties for prospective recycling. The previous methods of thermal recycling must be brought together for new approaches to material recycling and the associated material identification and separation.

48 Cf. 4.1.2. Sustainable plastics industry, section on functional integration.

49 Fire resistance in engine components is understood to be a minimum stability of 15 minutes when exposed to a 1,200°C kerosene burner flame. Duromers, e.g. from phenolic resins with special additives and coatings, are suitable for this purpose.



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Mechanical engineering, power plant technology and the construction industry also benefit from lightweight construction solutions made of composite materials. A major industrial company in the region that is highly committed to research and development is about to introduce a networked product development process (PDP) for hybrid lightweight structures. This is an example of the digitalisation of processes within a company from the Cluster. Here, a significantly improved interaction between the individual disciplines of construction, structural design and manufacturing of lightweight construction is to be established along the development progress. It is particularly important that findings on manufacturability and quality are taken into account at the design stage. The intensive cooperation between the Chair of Polymer-based Lightweight Design of the Brandenburg University of Technology Cottbus-Senftenberg and Wildau Technical University of Applied Sciences as well as the Fraunhofer PYCO research division enables companies to receive comprehensive support in this area. This means that small and medium-sized businesses in Brandenburg can also benefit from the cooperation between the scientific institutions.

To meet the demand for strengthening the circular flow economy, the **repairability and recyclability** of components must be taken into account right from the design stage. This process begins with the development of materials. Corresponding industrial cooperation, for example for the material recycling of rotor blades of wind turbines, are evidence of the existing competencies in Brandenburg.

The available plastics processing technologies include injection moulding, extrusion and a range of prepreg production options. Short fibres are used non-directionally as filling material mainly in injection moulding. Long fibres can align themselves during extrusion or injection moulding and thereby improve the mechanical properties. Continuous fibres can be aligned in the component in accordance with the load path. The latter is made possible by an automated fibre placement (AFP) plant for the production of highly stressed hull and shell elements, which was commissioned at the Chair of Polymer-based Lightweight Design at the Brandenburg University of Technology Cottbus-Senftenberg. The robot-guided laying of the fibre with high reproducibility promises defined qualities for series applications. The reinforcement with long or continuous fibres results in mechanically and sometimes also thermally highly stressable components.

### Economical and energy-efficient manufacturing technologies

International competition is a constant driving force for improving economic efficiency, also in lightweight construction. The focus is on **material costs** as well as on **manufacturing processes**, including pre- and post-treatment operations. Substituting energy-intensive processes (e.g. autoclave processes) can often also reduce production times and costs. This requires a comprehensive understanding of materials, design and processes, which has been brought together at the university and research locations under the thematic umbrella of “lightweight construction”.

Project examples of the use of more recent alternative curing methods demonstrate that the services offered to companies are structured in a target-oriented manner. To this end, it is recommended that the established competence centre for energy- and resource-efficient lightweight construction be further developed into a **competence centre for plastics processing and lightweight construction technologies**, to serve as a hub where companies can network with science and research.

### Additive manufacturing

The additive manufacturing process is ideal for the **material-efficient design of lightweight components**. The cooperation of the scientific partners at the Brandenburg University of Technology Cottbus-Senftenberg, Wildau Technical University of Applied Sciences and the Fraunhofer PYCO research division makes it possible to develop materials and new processing technologies for thermoplastics and thermosets. Plant equipment and expertise have been expanded in recent years at the locations in Wildau (key focal

point Duromers[50]) and Cottbus (key focal point Thermoplastics[51]), so that solutions in the areas of materials and processing methods can be developed and tested for real-world partners at short notice. Another important development task is the production of sustainable 3D printing materials.

### Reuse and recovery (recycling)

Repair and recycling technologies must be developed in particular for fibre composite components. The focus here is on **mechanical** and **chemical processes**, the use of which is determined by their effectiveness. Furthermore, efforts must be made to ensure that the materials used[52] are biodegradable and to increase the use of renewable raw materials. To achieve these goals, extensive material development is necessary. Tests on a pilot plant scale have shown that the recycling of fibre-reinforced duromers is possible and that both the monomers and the fibres generated in the recycling process can be reused.[53] The components made from recycled material have almost the same mechanical properties as components made from new material. Industrial demand in this field has developed very positively in recent years. The tasks can be funded under the various research programmes in this context at national and state-specific level.[54] The use of natural materials, such as rubber[55] and wood[56], in lightweight construction is also being tested. The industry's potential can be tapped through a controlled development of value chains for innovative recycling options, e.g. for decommissioned wind turbines, pipes from pipelines, floats and containers.

### Material characterisation and material models of lightweight materials and semi-finished products

Decisive for the use of lightweight construction solutions is the characterisation of the materials used, in the case of composite materials also their interaction. A large amount of material data[57] has to be established through **experiments** and **simulation** in an application-oriented manner so that it can be used for the design. Given the large number of effects and error-influencing factors, it is essential to include additional scientific expertise and material engineering resources here. Further findings are necessary both for lifetime considerations in component design and for ensuring component quality in quality and process control in production. This also includes the development of non-destructive testing methods, preferably as inline processes.

An additional field of material characterisation is offered by additive manufacturing. As the manufacturing process is not yet completely reproducible in some processes, various questions arise: What are the realisable strengths, plastic behaviour, temperature resistance and service life of the components? How can they be tested cost-effectively in production environments, also with regard to the integrated functionalities? These issues must be addressed in particular in close and trusting cooperation with industry partners.

### Lightweight construction in the construction industry

Lightweight construction is increasingly finding its way into the construction industry. One of the largest cost components in this field of application are the construction costs on site. The **industrial production of prefabricated modules** therefore offers significant savings potential. Moreover, a further lightweight construction motive is presumed here: Is it possible to create lightweight yet high-strength and sustainable load-bearing structures? Solution potentials are offered by intelligent module concepts in combination with the use of lightweight structures, e.g. realised with inexpensive high-performance fibres.[58] A special carbon fibre plant has been installed at the Fraunhofer IAP for this purpose. Another future field is the redevelopment of large-scale projects, e.g. buildings and post-mining landscapes.

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50 For example use of UV-curing polymers for printing or production of injection moulded parts with hard layers of UV-curing synthetic resins. This is not really additive production.

51 3D printing thermoplastics with continuous fibre reinforcement.

52 Current tasks for recycling and improving the sustainability of fibre composite structures, e.g. rotor blades of wind turbines, mechanical pulping (Brandenburg University of Technology Cottbus-Senftenberg), chemical pulping (Wildau Technical University of Applied Sciences).

53 M. Bauer, C. Dreyer, J. Lang and D. Söthje, Process for the recycling of materials containing phenolic resin, in particular phenolic resin-based fibre composites, Patent DE102016104518A1, 2016.

54 Together with the target group of small and medium-sized businesses, tasks can be applied for within the framework of the Central Innovation Programme for Small and Medium-Sized Businesses (ZIM); in this context, tasks for the recycling of plastic waste, for the recycling of thermosets, for the recycling of thermoplastics and for the recycling of concrete can be applied for.

55 Task: Biopolymers in reaction injection moulding.

56 Task: Post-utilisation concepts for waste wood.

57 e.g. material classifications, plastic, elastoplastic behaviour

58 Task: Lightweight structures in the construction industry. Here the Brandenburg University of Technology Cottbus-Senftenberg is working together with a regional scaffolding company on a novel product concept for lightweight scaffolding planks.

## 4.2 Cross-sectoral fields of action

### 4.2.1 Securing skilled employees for plastics and chemistry

The availability of well-qualified employees in the region is essential to ensure the sustainability of the plastics processing and chemical industry. Tasks and measures for securing a qualified workforce were already anchored in the first Master Plan in a wide range of fields, from vocational orientation in schools to continuing training in companies. The joint efforts of industry, educational institutions, universities, the social partners and the Cluster are showing positive effects. New activities were agreed in regular coordination meetings based on the analysis of measures introduced. This continuous and close exchange of ideas and measures, including the involvement of the industry's social partners, is seen as very positive by those involved.

However, the skilled labour situation is still seen by the business community as an increasingly problematic and limiting factor for a continuing dynamic economic development. The main reason for this is the demographic and economic development, which is causing the demand for labour in the state to rise sharply. Furthermore, some larger chemical companies are located in the peripheral regions (Schwedt, Schwarzheide), which are beginning to suffer particularly from a shortage of skilled employees. Experience to date shows that the establishment of measures only takes effect in the medium to long term. Here, the players urgently recommend that the approaches taken be pursued further and that the desired effects be analysed alongside the project. In addition, newly introduced technologies and digitalisation processes increase the need for continuing training. It is therefore in the interests of economic development to maintain existing vocational training capacities and support structures in Brandenburg, and where necessary to expand them in a targeted and demand-oriented manner and adapt them to changing needs.

The social component of sustainability requires "decent work" and individually tailored working and employment conditions. In addition to remuneration, offers for the compatibility of work and family and participation and involvement in professional matters, opening up career prospects through continuing training is becoming increasingly important.[59]

The structuring of the employment relationship, especially for academic employees, can also help to retain highly qualified staff, for example by offering attractive contract durations that allow employees to plan more long-term.

The approaches start with high schools, cover initial industrial vocational training, university education and continuing training in companies. In every phase, they must ultimately engage the apprentices and trainees and show them attractive prospects for the future. The current skilled labour situation in the commercial sector is described as a **"war for talent"**. The image of the plastics and chemical industries is seen as an essential factor here. This must be fundamentally reaffirmed in communication with the target groups, especially young people. The major upcoming social challenges that are to be met with sustainability goals offer new tasks and perspectives, including and in particular in the chemical and plastics industries. Continued concerted action by all Cluster players, companies, educational institutions, relevant chambers and associations, as well as the state administrations involved, is still essential to meet these challenges.

Due to its central importance for industry, the challenge of securing skilled employees is being addressed in a coordinated manner by the state government. Here, concrete measures for attracting skilled employees, vocational orientation, vocational and continuing training, especially for small and medium-sized businesses, and higher vocational education and training, e.g. at universities, are being pursued or initiated.

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59 Cf. Potsdam Model. The Potsdam Model is an initiative of IG BCE and AGV Nordostchemie, https://www.potsdamermodell.de/potsdamer-modell, accessed 24/01/2020.

The general objective of securing a skilled workforce, i.e. covering the immediate and future demand for skilled employees for the companies and research institutes of the two industries, is pursued through **strategic objectives** that build on each other.

- Shaping the image of the plastics and chemical industries in the context of current and upcoming sustainability requirements with new tasks and perspectives
- Necessity of strengthening career guidance for STEM professions, especially for the plastics and chemical industries in high schools and targeted communication towards young women
- Attractive design and modernisation of in-company initial and continuing training courses in accordance with the requirements of the companies, especially with regard to digitally supported processes
- Support for projects to further strengthen university education for tasks in the plastics and chemical industry
- Support for measures to strengthen educational institutions and support structures for securing a qualified workforce
- (Re-)recruitment of skilled employees externally
- Consideration of the "soft location assets"

Across all the following aspects of securing a qualified workforce the following is highlighted:

- **Good networking with other fields of action and priority sectors.** The establishment of working meetings and industry dialogues has shown to be effective. They should be maintained in any case and intensified as necessary. Other active players in the Cluster-relevant locations must also be involved.
- The **"soft location assets"** are particularly decisive for securing skilled employees at company locations. They should therefore be specifically advertised when recruiting skilled employees (e.g. childcare places, public transport connections, property prices, leisure facilities, etc.).
- The economic and educational players regard the **continuation of Cluster work** as an important factor for success.

From the point of view of the players in Brandenburg, the strategic objectives are described in detail in the following topics.

### Vocational and academic orientation

The first starting point for improving the skilled workforce situation is offered in high schools in the vocational orientation phase.[60] This is where the course is set for or against a career in the industry. Differentiation in the STEM[61] subjects that form the basis for technical professions or higher education takes place in the same way at this time.

Vocational orientation in the schools is anchored in the framework curriculum of high schools[62] in Berlin and Brandenburg, which was newly drafted in 2017. The handbook for vocational and academic orientation of LISUM[63] outlines approaches for the cooperation of schools with companies, with secondary school centres and with universities. In order to offer practical insights into industrial career prospects in particular, schools here depend on the commitment of regional companies.

The first good practices, which have already been initiated and supported by the players in the field of action "Securing skilled employees" and the Ministry of Education, Youth and Sport, include

60 At lower high school level (grades 7 to 10).

61 Subjects science, technology, engineering and mathematics.

62 Framework curriculum for secondary schools in Berlin and Brandenburg, 2017, focus on vocational and academic orientation, https://bildungsserver.berlin-brandenburg.de/rlp-online/b-fachuebergreifende-kompetenzentwicklung/berufs-und-studienorientierung/, accessed 13/09/2019.

63 Handreichung Berufs- und Studienorientierung mit Unterrichtsbeispielen für die Jahrgangsstufen 7 bis 10 im Land Brandenburg [Handout on career and study orientation with lesson examples for academic years 7 to 10 in the State of Brandenburg], publisher: Landesinstitut für Schule und Medien Berlin-Brandenburg (LISUM), 2018.

- **information platforms** on technical and scientific educational opportunities for pupils[64]
- **teaching materials and experimental units** for hands-on teaching[65]
- **career orientation internships** in Brandenburg companies
- **cooperation** with the Brandenburg universities[66]

**Teacher training** is an important success factor for technical and scientific career orientation. Learning content on digital skills and topics of technological innovation, as well as insights into the current operations of local companies, promote the link to the industry. Building on the encouraging results of the School 3.0 project in Hesse[67], **special teaching modules for lower and upper high school teachers** can be developed in cooperation with the Research Group Didactics of Chemistry at the University of Potsdam. The main goals are vocational orientation, professional qualification, especially in STEM subjects, and future orientation with innovative subject areas.

In order to improve the situation regarding skilled employees, especially with regard to shaping vocational and academic orientation for technical professions, the **cooperation of the players in the Cluster** must be further intensified. It is important to consider the effects of the established programmes when devising career guidance, particularly in cooperation with the Ministry of Education, Youth and Sport and the Ministry of Science, Research and Culture, and to make proposals for further development where necessary.

### Vocational and continuing training

Vocational and continuing training for the professions in the plastics and chemical industries must keep pace with **technological developments** in machine technology as well as new manufacturing processes, such as additive manufacturing, and increasing quality requirements, which are reflected in process-accompanying measurement and control methods. Furthermore, the digital networking of plants and production lines, embedded in a company software, also fundamentally changes the nature of the fields of activity of technical employees.[68] Likewise, practice demands **interdisciplinary and social skills** such as reliability, punctuality, goal orientation, the ability to work in a team, foreign language and intercultural skills as fundamentally important for the value creation of the companies. The young apprentices must be offered attractive career prospects and at the same time be expected to perform well in their field. Here, the training providers have the task of developing and offering up-to-date training content and didactic concepts in close cooperation with the industry. A current challenge is the acquisition of apprenticeship places in small and medium-sized businesses. The Jobstarter project has

64 A good example is the portal “Lusatia – strong STEM region” of Wirtschaftsregion Lausitz GmbH in cooperation with the Federal Employment Agency, Wirtschaftsinitiative Lausitz and the Economic Development Agency Brandenburg, which provides information about current educational opportunities for pupils in the Lusatian region, including adjacent offers in Saxony, Saxony-Anhalt and Berlin. https://www.mint-lausitz.de, accessed 13/09/2019.

65 “Kunos cool plastic box” with five experiments for the primary level, distributed by the Association of Plastics Manufacturers in Germany, PlasticsEurope Deutschland e. V.
“TuWaS! in Brandenburg” – the project networks schools, education authorities and commercial businesses to enable the purchase of experimental units on various topics. Participating primary and special schools form a local school network. The project started as a pilot project in the Uckermark region in the 2016/17 school year. Currently 22 primary schools and one special school are using the experimental units thanks to generous donations from Brandenburg entrepreneurs. Source: http://www.tuwas-deutschland.de/brandenburg.html, accessed 13/09/2019.

66 Mobile pupil laboratory “Science on Tour” is a project of the Brandenburg University of Technology Cottbus-Senftenberg. The mobile student laboratory offers Brandenburg students at the upper high school level (Sekundarstufe II) the opportunity to work independently at laboratory level on site in the classrooms of their own school. The practical and hands-on range of offers is intended above all to inspire pupils to take an interest in science and technology. Source: https://www.b-tu.de/scienceontour/, accessed 13/09/2019.

67 “School 3.0 – Future technologies in the classroom”: an initiative to strengthen STEM career orientation in all types of schools, a project of the University of Cologne, TU Darmstadt, the companies Merck, Umicore, SolviCore 2016 to 2018.

68 In recent years, for example, there have been regular consultations with the Cottbus Chamber of Commerce and Industry on the amendment of the vocational training professions.

achieved[69] initial success in this area.[70] An effective instrument is to make special achievements visible in a way that has an effect on the apprentice and the training company, e.g. in the form of public award ceremonies. Here, personal awards for special achievements by apprentices were added to the Cluster's innovation prizes.[71] In this context, **the high school centres** located in Brandenburg fulfil an important part of vocational education and training. Support should be given in this context to measures to better market the particular offers, especially with regard to practice-oriented teaching programmes, the unique features of vocational training for technicians, as well as the options for obtaining a Fachhochschulreife (entrance qualification for studies at universities of applied sciences) and the educational permeability that can be achieved with it. Effective vocational training cannot take place without the participation of the companies. More and more companies need to be motivated and supported with regard to the creation of in-company vocational training programmes. By providing future-oriented joint training opportunities, even the smallest companies can be enabled to provide in-company vocational training.

The state government intends to further strengthen **dual vocational education and training**. A broad-based information campaign is to be launched to make career opportunities and connection possibilities better known among families with children and young people. To this end, the vocational training campaign "Brandenburg will Dich! Hier hat Ausbildung Zukunft" ["Brandenburg wants you! This is where training has a future"] has been further developed. Furthermore, publicity campaigns are intended to promote the reputation of vocational education and training in society in general in order to attract more young people to the dual education system.

The **continuing training** of employees in companies is seen as a broad and challenging field. Continuing training is often carried out "on the job". In day-to-day business, current customer orders often take priority. It is therefore necessary to compile practical continuing training offers for companies, which on the one hand address current technology needs and are offered in small teaching modules, and are also complemented by individually retrievable digital teaching modules, in a practice-oriented manner. Here, the Ministry for Economic Affairs, Labour and Energy provides suitable support measures for companies.[72]

### University education

University education in the key focal points represented by the Cluster is **highly focused in terms of subject matter and content**. In the field of chemistry, there are courses offering a classical, broad-based education in chemistry (University of Potsdam) as well as a university course in materials chemistry (Brandenburg University of Technology Cottbus-Senftenberg), which specifically focus on chemical materials design and offer training in the core chemical subjects as well as in related scientific and engineering fields.

In the field of plastics and the technologies for their processing, Brandenburg's universities offer university courses in the areas of Soft Matter (University of Potsdam, in part also with the Berlin universities, Master of Polymer Science) and Nanoscale Materials (University of Potsdam, joint professorships with the Max Planck Institute of Colloids and Interfaces, Fraunhofer IAP) with particular opportunities for specialisation. Polymer materials and plastics also form modular key focal points in the mechanical engineering university courses. This spectrum of vocational training profiles at the universities creates the broad range of content necessary for securing a qualified workforce in the Cluster. At the same time, the **clear profile** avoids redundancies

69 Development and certification of additional qualifications for biology and chemistry laboratory assistants in Berlin and Brandenburg, project of the Lise Meitner School, upper high school centre for science in Berlin, funded by the Federal Ministry of Education and Research (BMBF), duration 09/2013–08/2016.

70 With the follow-up project Jobstarterplus 2016–2019, which aims to reduce staffing and matching problems and to increase the value and potential of vocational education and training, 51 companies were advised and 28 new vocational training places were created.

71 Establishment of the prize for Best Apprentice in Plastics Processing with the "Baekeland Prize" of the KuVBB e. V. (awarded for the first time at the Cluster conference 2016) and from 2017 for Best Chemical Technician with the "Max Bodenstein Prize", which was initiated by the Cluster and taken over by the VCI LV Nordost.

72 Continuing training guideline of the Ministry for Labour, Social Affairs, Health, Women and Family (MASGF), https://www.ilb.de/de/arbeit/uebersicht-der-foerderprogramme/foerderung-der-beruflichen-weiterbildung-im-land-brandenburg/, accessed 13/09/2019.
On 20 November 2019, the formation of the government led to changes in the designation of departments and the structure of the ministries. With the new formation of the government, the MASGF unit that deals with in-company training has been integrated into the newly structured Ministry for Economic Affairs, Labour and Energy (MWAE).

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in the state and ensures that training resources are used efficiently.

Despite the great commitment of the universities in recruiting students, the number of first-year students has fallen continuously in recent years. Here, demographic change is also making itself felt in higher education. The lack of appeal of technical-scientific university courses has a far greater impact. Image building begins at school. Likewise, it is also important to address parents when it comes to raising awareness of technical careers. The university locations in Brandenburg are becoming increasingly **important for company settlements**. In-company continuing training courses, such as dual university courses, create a firmer foothold in the region. For this reason, the aim is to expand the **range of dual university courses**, possibly also as part-time models in which students can continue to pursue their professional activities in parallel.

Against this background, the players in the Cluster are still committed to providing **comprehensive and future-oriented training for the plastics and chemical industry** at the universities in the state. To this end, the range of qualifications in central and future-oriented chemistry, plastics and lightweight construction skills should be further developed, including for use in small and medium-sized businesses in Brandenburg. This would make it possible to increase the number of new students and meet the needs of companies and research institutes in the region, especially with regard to structural change.

### Qualifications of executives

The companies in the state need excellently trained specialists at all hierarchical levels of corporate structures. This also includes **executives** with a high-quality academic education and the ability to work independently and creatively in **research and development**.

In the field of natural and engineering sciences, these competencies are acquired primarily through work in scientific projects at universities and non-university institutions. Graduates of the state's universities in the field of plastics and chemistry should increasingly be given opportunities for the structured advancement of junior scientific staff within the framework of coordinated programmes (graduate schools). Examples include the already existing programmes, such as the Potsdam Graduate School or the Graduate Research School of the Brandenburg University of Technology Cottbus-Senftenberg. There is also an increasing demand for opportunities to teach soft skills such as personnel management, project management, etc.

## 4.2.2 Sites and logistics for plastics and chemistry

Brandenburg is home to companies in the plastics technology and chemical industries, some of which have established themselves in excellent, sometimes historically significant locations. The connection to pipelines and rail or road transport arteries is a fundamental location asset, especially for large chemical companies. The individual companies are often linked to each other via value creation networks. **Spatial proximity** also plays an **important role** in terms of securing skilled employees and networking among the players. For instance, **universities and research institutes act as catalysts** for nearby companies and often motivate start-ups to settle in the area.

The analysis of the success-critical framework for companies in the plastics and chemical industries has shown that the basic requirements for companies in the plastics and chemical industries differ. While the Schwedt (petrochemicals), Schwarzheide (speciality chemicals) and Schwarze Pumpe (water/waste water, energy) sites are characterised by **process-specific infrastructure**, the plastics industry sites, for example Guben (fibres, foams), Premnitz (synthetic fibres, engineering plastics, recycling), Neuruppin (plastic products) and Wildau (technology and application development**) have developed and distinguished themselves in terms of production and application-specific unique selling points**.

The basis for this is the further development of the concept of “regional growth cores” and Cluster policy towards innovative growth corridors in order to create structural support that targets the area. These corridors are to be developed along the central transport axes and connect the regional growth cores with Berlin and other major cities, thereby creating the prerequisite for efficient logistics links between the locations and to the markets.

The following are named as central **location assets**:

- Available areas for industrial settlements and expansions
- Investment required for the development of new sites
- Connection to the rail network and combined transport terminals KVT
- Media supply for electricity and steam
- Digital infrastructure

Other important **environmental assets** are

- access to the customer, access to the supplier
- the availability of a qualified workforce
- regional access to research facilities
- the acceptance of industrial value creation in the community

The areas of “locations” and “logistics”, which were still considered separately in the first Master Plan, will be brought together in one field of action due to the close cooperation of the players so that the synergies can be implemented more quickly.

The **overarching strategic objective** is to **ensure the long-term competitiveness** of the developed plastics and chemical locations in Brandenburg.

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This is achieved by

- targeted support for the further profiling of the locations for companies and investors
- strengthening companies in internationalisation efforts and strengthening transnational and international cooperation with relevant players, networks and initiatives
- improving logistics connections with regard to all relevant modes of transport, removing bottlenecks in transport infrastructure and combined transport to improve access to the new international growth markets
- shaping the framework for improved economic use of renewable energies and promotion of technologies for energy storage (Power-to-X), for example hydrogen as an alternative energy source
- intensified networking with customer and user industries resulting in expanded and stable value creation systems
- intensified networking with university and research institutes to raise the professional profile and secure the future of the locations

The Cluster’s objectives can develop their full impact if the necessary framework for a balanced and beneficial industrial and environmental policy and for the preservation of the industrial foundation is shaped proactively. This also and especially includes the creation of attractive living conditions to secure the qualified workforce potential in rural Brandenburg.

### Promoting further technical development of plastics and chemical sites, improving the logistics connections

The analysis of the players in the fields of action of locations and logistics has shown that, in addition to the above factors, **support services** for settlement and expansion as well as **permits** and **subsidies** have a positive **effect on business location decisions**. **Coordinated action** beyond the Cluster remains necessary with regard to framework conditions such as the availability of qualified employees, logistics connections, statutory charges and energy levies. Decisive factors for success are short and transparent approval processes as well as sufficient processing capacity at the responsible agencies and authorities, in order to be able to keep up with international competition when it comes to attracting companies.

Good logistics connections are a prerequisite for the operative business, both for goods and for the people involved – as employees, value creation or development partners. Moreover, in the course of advancing digitalisation, there is currently still a need for the provision of sufficient digital infrastructure (fixed network and wireless bandwidths).

The work carried out so far in the field of action shows that **coordinated and joint representation of the interests** of the players in the Cluster has had a beneficial effect. This has already been demonstrated in the support for measures for the demand-oriented expansion of transport infrastructure with connections to long-distance routes.

The plastics and chemical sites can be further developed in the long term through supra-regional **marketing strategies** that focus on the aforementioned central location and environmental factors. Specialist areas of expertise offer advantages in the further development of the individual locations. For example, the objective of promoting and strengthening technologies for battery research and the production of environmentally friendly synthetic fuels has advantages for the state.

### Internationalisation to support the development of the location

The decision to cooperate with foreign partners or to tap into new foreign markets is an important aspect of **corporate development**. There are already numerous connections to companies and scientific institutions in neighbouring countries with the aim of joint R&D projects. New contacts with potential partners are established through presence at leading international trade fairs. **Support services** for internationalisation activities are already offered here by the state's Economic Development Agency and the Chambers of Commerce and Industry, among others.

In addition to the internationalisation of economic relations, international cooperation in **research and development** is also to be strengthened. As a result of their scientific approach, universities and research institutes here are generally well connected internationally. For example, the contacts of the Brandenburg University of Technology Cottbus-Senftenberg with neighbouring countries have already initiated new projects. This orientation enables an intensive exchange across borders and can open up new markets.

### Promote framework conditions for the industrial use of renewable energies

The **cost-effective use of electrical energy** and, in the future, **primarily renewable energies** is an essential prerequisite for the successful sustainable development of industry in Brandenburg and, due to its already high potential for the expansion of renewable energies, represents a state-specific location advantage. Simplification of the regulatory framework is of particular importance in this respect.

The Cluster therefore supports initiatives that maintain and promote competitiveness, especially of energy-intensive companies. Aid for electricity-intensive companies is to be granted in accordance with European state aid law. Efforts are to be made to adapt the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz, EEG) so that electricity generated from renewable energy sources is increasingly used directly in the regions where it is generated. The transparency of the $CO_2$ reduction effect of sustainable materials and processes is also to be increased so that reliable calculation bases can be used to substantiate the economic efficiency of the new industrial processes.

In **real-world laboratories and pilot areas**, frameworks that are limited locally and temporarily can be adapted and simplified specifically for the use of renewable energies (such as grid fees, especially for self-produced electricity) with the aim of demonstrating the feasibility of sustainable value creation systems and providing references and success factors for sustainable economic systems at national level. In this context, the concept of a real-world laboratory should be defined more broadly in order to enable competitive procurement of renewable energies, both in terms of the necessary investments and in terms of operating costs. Here, important

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success factors for the industry players in Brandenburg have to be identified in order to be able to provide further impetus for the continued development of the federal funding guideline, including for real-world laboratories.

The locations of the Cluster Plastics and Chemistry are ideal for using **networks with different industries** to develop specific advantages for the region. The locations in Lusatia, for example, provide excellent conditions for establishing a close link between the speciality chemicals and energy industries with the aim of creating sustainable added value. Locations close to Berlin can benefit from the proximity to research sites in plastics technology and chemistry as well as to other sectors such as the health or food industry. Berlin also provides a large test market for innovative products and services.

### 4.3.2 Markets and technologies

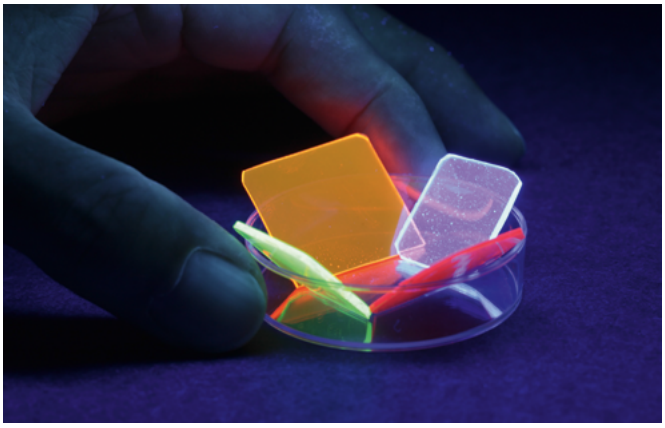
The first Master Plan of the Cluster Plastics and Chemistry already focused on technology-oriented fields of action with strong growth potential. This will be continued with the present revised Master Plan. In order to continuously consider the development of markets and technologies even during the implementation of the Master Plan and to be able to incorporate this into the work of the Cluster players if necessary, the new cross-sectoral field of action "Markets and technologies" will be introduced, whose task it is to identify and develop new fields of action both by **observing market developments** and through **exploratory research**.

For Germany, the chemical industry has always had the role of an enabler (catalyst) for progress and prosperity. Chemical and plastics solutions continue to be sought after in order to meet current and upcoming sustainability challenges. It is to be expected, for example, that the increased demand for sustainability will drive innovation in many economic sectors. In the energy sector the use of renewable energies is being promoted, in the mobility sector the means of transport are being converted to new drive technologies, and, in the case of everyday goods, the products are being upgraded with a view to a circular economy. The focus must be on the **marketability** of such innovations and their targeted development. Particularly in view of the international and digitised competition, it is becoming increasingly important to keep an eye on market developments and to recognise and assess any opportunities or risks that may arise for players in the Cluster. Here, it is particularly important to have a long-term perspective when identifying disruptive developments and new business models and analysing these with regard to value creation in the Cluster. The technical possibilities must be coupled with **market relevance**, so that a value creation that is **both specific to Brandenburg and sustainable** can be achieved.

The players in the plastics and chemical industry are often at the very start of value chains and therefore far removed from market-induced innovations. In this context, **cross-cluster** means identifying relevant topics related to one's own field of expertise together with players from other clusters and economic sectors in Brandenburg and evaluating them in terms of their market relevance. This allows players from the Cluster Plastics and Chemistry to be involved more quickly and directly in innovation processes of other clusters. Market-related trend research and cross-cluster activities are particularly valuable for small and medium-sized companies with highly specialised value-adding components. In order to systematically pursue a more far-reaching open approach to the future, the Cluster's players therefore recommend that the Cluster's current **work and exchange structure with its openness towards technology** be retained.

**Strong research at the state's universities and research institutes** is an important prerequisite for being able to address topics such as sustainability and energy and resource efficiency more intensively. This enables "leap-frog innovations"[73] that result from the application of pacesetting and

73 In future, the BMBF will support such "disruptive" innovations through the "Agentur für Sprunginnovationen", https://www.bmbf.de/de/agentur-fuer-sprunginnovationen-9677.html.



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key technologies. Such not yet established scientific and technical ideas can be used by start-ups to establish new business ideas/new value chains in the Cluster in the long term.

At the same time, **scientific research** is revealing new dimensions of the effects of climate change and an improved understanding of their causes and determining factors. Here, a discourse must be held on the extent to which the players in the Cluster can contribute to solutions, for example to the reduction of $CO_2$ emissions. It is therefore a special task **to discuss the identified fields of action and the potential for solutions in the context of the central themes of sustainability**.

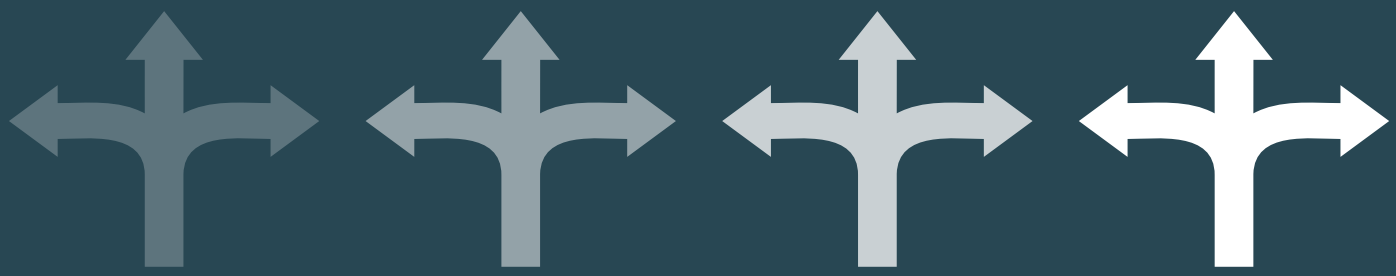
The following **strategic objectives** are envisaged for the new field of action “Markets and technologies”:

- Active identification and promotion of promising and even disruptive fields of innovation within the Cluster’s key focal points or in cooperation with other clusters and economic sectors (cross-cluster)
- Taking into account the competencies, infrastructures and economic structures of neighbouring regions and international partners to form development and value creation alliances
- Communication of the solution potential of the players in the Cluster Plastics and Chemistry on central sustainability issues.

Before work can begin in this field of action, the content-strategic orientation must first be determined with the Cluster players in order to **identify and address future topics and markets** that are particularly relevant for the Cluster’s industries. For example, in a first screening the individual topics of electrochemical conversion are to be considered. Other fields of technology should be identified through a systematic technical approach, for example in the cross-cluster potential for the Clusters Energy Technology and Transport, Mobility and Logistics:

- Requirements resulting from the consistent continuation of the energy transition in Brandenburg for the players in the plastics and chemical industry
- Chemicals, processes and products required in the context of the broad adoption of electric mobility, including fuel cell vehicles
- Consequences resulting from a $H_2$ value creation system integrating energy technology, mobility and chemistry
- Functional requirements for plastics of future (e.g. autonomous) transport modes
- Identification of gaps in the circular economy models to be aimed at for possible value chains in Brandenburg

These questions can be illustrated and made comprehensible through consistent market and technology scenarios, and development paths – starting from the current actual situation – can be shown.



# 5 Key focal points and guidelines

# 5 Key focal points and guidelines

With its fields of action and development directions, the Master Plan of the Cluster Plastics and Chemistry represents a tangible specification of the Regional Innovation Strategy of the State of Brandenburg (innoBB 2025 plus). In addition to the Cluster's own key focal points, it identifies four overarching key focal topics that apply to all clusters: digitalisation, real-world laboratories and test fields, Work 4.0 and skilled employees as well as start-ups.

These key focal topics are addressed in various ways by the players of the Cluster Plastics and Chemistry in the form of strategic goals and implementation measures in the fields of action. Especially the key focal topic "Work 4.0 and skilled employees" is reflected in the fourth field of action "Securing skilled employees", which was already given priority by the players in the first Master Plan and is now covered by current tasks and projects. In addition to these four main key focal topics, the tasks of cross-cluster networking and internationalisation are also addressed below.

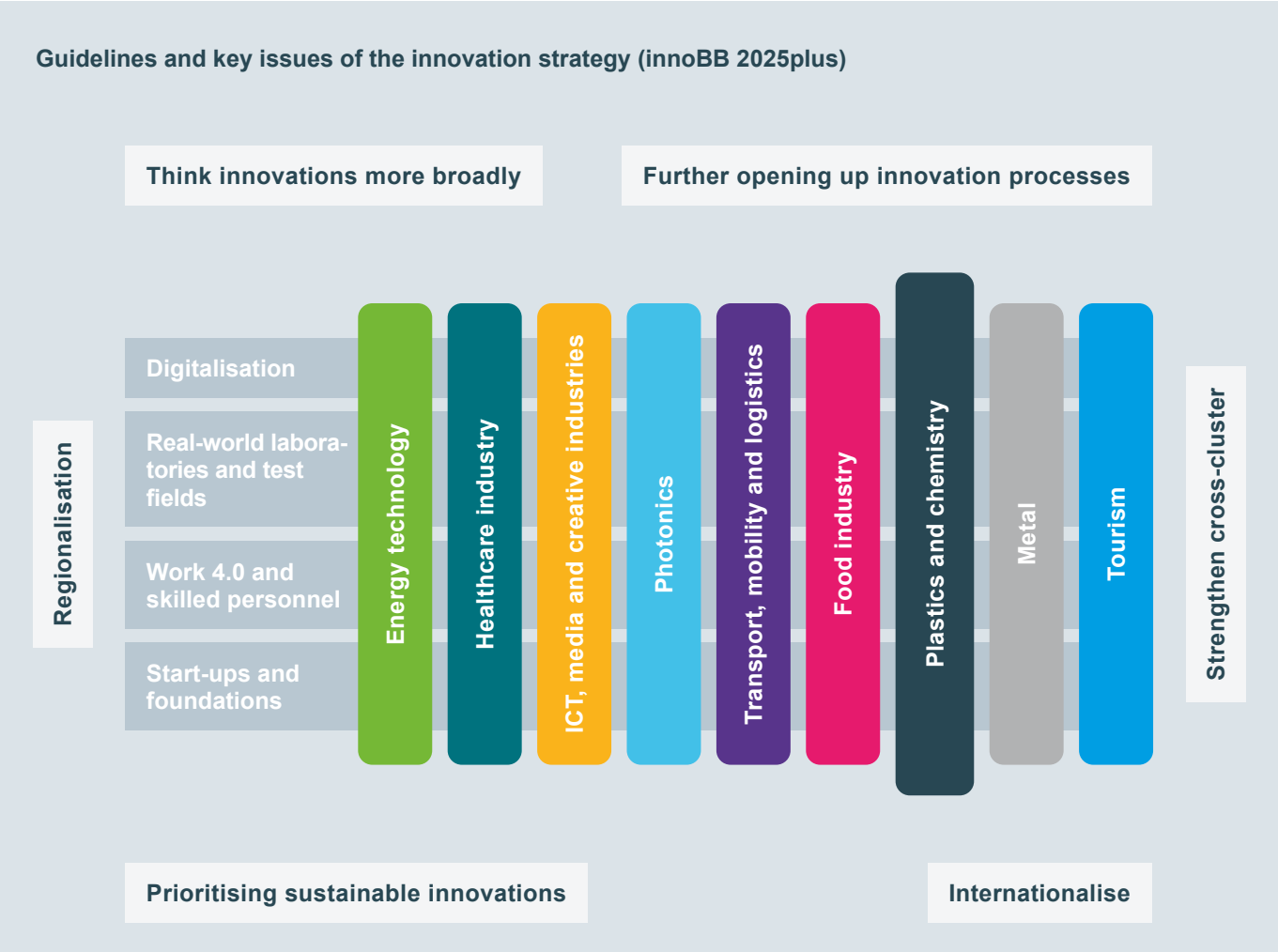


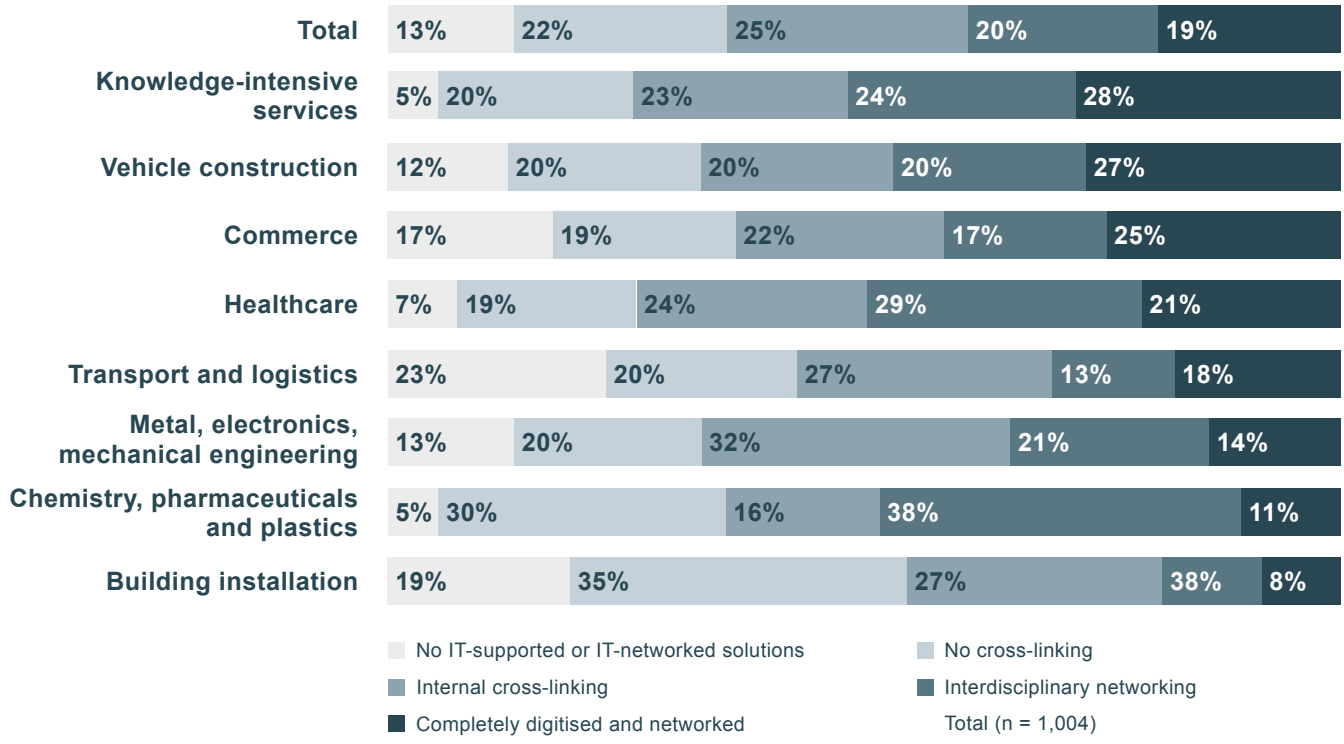

Figure 4: Regional Innovation Strategy of the State of Brandenburg, source: WFBB, 2019

## 5.1 Digitalisation

Digital technologies permeate almost all areas and business processes in companies and enable productivity gains and new solutions in research and development. This also applies to the players in business and science in the Cluster Plastics and Chemistry. The individual aspects of digitalisation **listed in the fields of action** demonstrate the breadth of applications of digital systems and processes.

In a company survey[74] carried out in Brandenburg in 2017 on the **status of digitalisation**, companies in the chemical, pharmaceutical and plastics industries scored mid-range. While 49% of the companies stated that they were fully or at least cross-departmentally networked through digital systems, 35% of the companies had no networking or IT support. This suggests that there is considerable potential for digitalisation, especially in production and distribution. A survey in 2019 also shows that a large part of the effects of digitalisation will be seen in order control, logistics and supply chain management.[75] Just as in other industries, the

Figure 5: Digitalisation status of companies in Brandenburg (self-assessment of 1,044 enterprises, 2017)




74 Project “Arbeit 4.0 in Brandenburg – Digitalisierungsprozesse in ausgewählten Bereichen der Brandenburger Wirtschaft und deren Auswirkung auf die Organisation und Gestaltung von Arbeit” [“Work 4.0 in Brandenburg – Digitalisation processes in selected areas of Brandenburg’s economy and their impact on the organisation and design of work”] on behalf of the Wirtschaftsförderung Land Brandenburg GmbH (WFBB Arbeit), carried out in 2017 by the consortium IMU-Institut Berlin GmbH, Forschungsteam internationaler Arbeitsmarkt GmbH (FIA), Umfragezentrum Bonn – Prof. Rudinger GmbH (uzbonn), Prof. Dr. Sabine Pfeiffer.

75 When asked about the greatest potential of digitalisation at the 17th Schwarzheide Plastics Colloquium, September 2019, the following were indicated:
20% material development, design, construction
28% machine/system control, quality assurance
45% order management, logistics, supply chains
8% distribution, digital platforms (B2B).

awareness of the opportunities and risks[76] of digitally supported processes in companies must be increased. In view of the challenges and changes here, timely involvement of the social partners is essential. It is possible to transform industries and companies by working together – also with the assumption that employees are involved in change processes in good time.

In Berlin and Brandenburg, the players in digital technologies are networked in the ICT, media and creative industries innovation cluster. Therefore, potential **digitalisation tasks** are also **cross-cluster** topics with solution providers from industry and science, which need to be tackled more intensively.

## 5.2 Real-world laboratories and test fields

Product and process innovations, especially in the plastics and chemical industry, require longer periods of time compared to other industries, e.g. telecommunications. In particular the upscaling of prototypes and laboratory plants to series production usually requires one or more intermediate stages (testing facility, pilot plant) with accompanying development and planning work. In addition, the manufacturing processes are often highly networked in terms of materials and energy. Here, real-world laboratories as a special organisational form for the concerted implementation of projects can help to realise even complex system structures with several value-adding partners from different industries on a pilot scale. Particularly in areas where energy-intensive processes are required or renewable energies are to be used in order to reduce **high $CO_2$ emissions in industrial processes**, indications for regulatory framework conditions can be reliably derived from the tests and incorporated into national or EU-wide regulations. In this respect, the existing infrastructures and industrial plants as well as the competencies built up over many years at the locations of the Cluster and the energy sector offer good conditions for the construction of pilot and demonstration plants which provide a model.

According to the definition of the Federal Ministry for Economic Affairs and Energy (BMWi), real-world laboratories are characterised by the following three features:[77]

- "Real-world laboratories are test spaces limited in time and space in which innovative technologies or business models are tested under real-world conditions."
- "Real-world laboratories use legal leeway."
- "Real-world laboratories are associated with a regulatory knowledge interest."

Even if the model of real-world laboratories has emerged from the fields of automated driving, networked production systems or Smart Cities and appears particularly suitable for these purposes, the aforementioned features are also compatible with the Cluster's tasks as specified in the fields of action. Real-world laboratories and model regions can be organised and promoted in particular to strengthen structurally weak regions or those affected by structural change, which are however distinguished by a special profile.

Apart from technological feasibility, user acceptance is a prerequisite for economic success. Particularly those tasks that aim to improve sustainability lend themselves to the testing of new concepts in **test fields with the involvement of users** and to promote awareness, for example for energy saving or recycling. For example, a real-world laboratory makes it possible to test the **recycling efforts for plastic waste** in greater detail and make them visible. Another application is the establishment of a value creation system for the production of **bio-based speciality chemicals** that are used for the production of **biopolymers**. Throughout the State of Brandenburg, **regenerative energies** can be developed in a coordinated manner using **$H_2$ technologies** as pacesetters of a sustainable energy economy, coupled with innovations in sustainable **industrial production and mobility**. The communication of best practice in turn leads to a **positive perception** among the general public and contributes to promoting a positive image of the industries.

76 Topics of IT security and strengthening the resilience of systems and facilities against cyber attacks.

77 Federal Ministry for Economic Affairs, Labour and Energy (BMWi): "Freiräume für Innovationen – Das Handbuch für Reallabore" ["Scope for Innovation – The Manual for Real-World Laboratories"], July 2019.

## 5.3 Work 4.0 and skilled employees

Innovations are achieved by well-educated people in a favourable environment. The need for good education and continuing training has already been outlined in the field of action “Skilled employees”. The players in the Cluster Plastics and Chemistry have already recognised the importance of securing skilled employees as a separate field of action in the first Master Plan. The experience of recent years confirms the need for the actions taken, but also their long-term impact. The additionally required skills in the handling and development of digitally operated processes have in the meantime further aggravated the skilled labour situation against the background of a corresponding demographic development. With the introduction of the measures identified in the field of action, the path taken will be continued with increased intensity. In order to meet the challenges of securing skilled employees, the social partners are working together with their expertise and experience.

## 5.4 Start-ups and new businesses

Establishing a company in the plastics and chemical industry is generally associated with more inherent and financial risks than for instance in the digital start-up sector. **Research-intensive start-ups**, which are often based at university locations or research institutes, are dependent on needs-based funding and support services, such as start-up advice, the temporary provision of workshop and laboratory capacities, and innovation and investment subsidies. But start-ups can also be effectively supported by networking and creating public awareness, e.g. by means of award ceremonies.[78]

## 5.5 Strengthen cross-clusters

Although the contributions of plastics technology and chemistry are increasingly at the beginning of value chains and systems, their technological findings have often led to new solutions.[79] There are currently a number of social challenges to be solved with the aim of improving sustainability. Competencies in plastics technology and chemistry can – also in cooperation with other knowledge domains such as information and communication technologies – contribute to a reduction in energy consumption, avoid $CO_2$ emissions, reduce material consumption or offer new solutions with improved functionality. The examples of cross-cluster tasks and solutions listed in the fields of action demonstrate the diversity of the different solutions.

78 For example, the Berlin-Brandenburg Innovation Prize and the Cluster Innovation Prize have already helped a number of small companies achieve the desired visibility.

79 It should be remembered here that the groundbreaking discoveries in chemistry at the beginning of the 20th century enabled significant advances in medicine, agriculture and the consumer goods industry.

Overview of potential cross-cluster topics:

| | |
|---|---|
| **Energy technology** | • Energy-efficient technologies<br>• Renewable energies (photovoltaics)<br>• Repair and recycling of wind turbines<br>• Functional integration in materials<br>• Functional surfaces and new catalysts<br>• Energetic recycling of residues<br>• Hydrogen production/storage/use<br>• Battery materials, production, recycling<br>• New materials, e.g. for heat storage<br>• Lightweight construction<br>• Energy supply for industry |
| **Food industry** | • Biogenic recyclables for the chemicals and plastics industry<br>• Functionalisation of polymeric and biopolymeric materials<br>• Recycling of biodegradable residues<br>• New packaging materials<br>• Traceability in cold chains<br>• Films for agriculture (degradable)<br>• Lightweight construction for devices/equipment |
| **Healthcare industry** | • New materials (implants, medical devices, consumables)<br>• Surface modification (antibacterial, easy to clean)<br>• Biologisation of plastics<br>• Functionalisation of polymeric and biopolymeric materials<br>• Bio-based raw materials for life sciences<br>• Industrial biotechnology<br>• Health management/securing skilled employees |
| **Metal** | • Composite materials, lightweight construction<br>• New materials for machinery and plant engineering<br>• Development of new materials and manufacturing processes (hybrids and multi-material composites) |
| **Tourism** | • Nature tourism<br>• Functional surfaces in hygiene areas such as kitchen and sanitary spaces<br>• Boat building (hulls, new materials, “shark skin”) |

| | |
|---|---|
| **ICT, media and creative industries** | • Digitalisation, data and process security (Industry 4.0)<br>• Tracking of flows of goods<br>• Digital education and continuing training<br>• Product design (lightweight construction, new materials, recyclable design)<br>• New production processes (3D printing)<br>• VR/AR for system maintenance |
| **Transport, mobility and logistics** | • Lightweight construction, insulation, insulation of vehicles<br>• New materials and material combinations for the energy- and resource-efficient production of vehicle components<br>• New materials, functional surfaces, functional integration<br>• Biologisation of plastics<br>• Alternative (synthetic) fuels<br>• Logistics for industry |
| **Visual technology and photonics** | • Analysis, sensor technology (process monitoring, product and material recognition, monitoring of composite components, sorting processes in recycling)<br>• Optical technologies in production/material processing (laser)<br>• New materials for optical components<br>• Surface coatings |

Cooperation in the sense of a sustainable bioeconomy must be strengthened across all clusters that use biogenic resources. This applies in particular to the Clusters Plastics and Chemistry, Food Industry and Healthcare Industry, but also Energy Technology and Tourism. The central question as to which new overarching topics lie ahead for the Cluster Plastics and Chemistry will be systematically pursued in the field of action “Markets and technologies”. Here, the cross-cluster approach is of central importance due to the interdisciplinary approach and the development and use of informal and formal working structures of technology transfer and Cluster management.

## 5.6 Internationalisation

The topic of internationalisation varies in importance across the individual areas of the Cluster. The subareas of the Cluster Plastics and Chemistry have varying degrees of export orientation. The average **export share** of the total turnover is about 35.3% in the production of rubber and plastic goods and almost 20% in the production of chemical products.

Like the industry as a whole, Brandenburg as a chemical and plastics location is also facing elementary strategic and structural challenges. One of these is the **growing competition** in Asia, South America and, in the longer term, Africa, where new production capacities are being established and expanded in regions rich in raw materials. Furthermore, a **paradigm shift in demand structures** and **social objectives** has been taking place for some time. The efficient and environmentally friendly use of resources through a circular economy is also becoming increasingly important in international competition. Likewise, **digitalisation** is bringing about comprehensive changes in all sectors of the economy. These core topics decisively determine the international development trends in chemicals and plastics.

International competitiveness is an integral part of business development in most Cluster companies. However, this is often not tackled in a targeted manner, as there are **hurdles** that are difficult for an individual company to overcome. The state government provides support for certain issues of internationalisation.

The internationalisation activities of the Cluster management focus on the **initiation and support of international innovation cooperation**. International trade fairs (in Germany and abroad) such as ACHEMA (leading international trade fair for the process industry and chemical engineering), FAKUMA (trade fair for plastics) and K (largest international trade fair for plastics) as well as various supplier trade fairs play an important role in the cross-border networking and contact building of Cluster players as well as the development of strategic partnerships with international clusters.

A key focal topic for the coordination of international activities in the Cluster Plastics and Chemistry is the **bioeconomy**. Since 2015, the international conference “Bio-based Economy” has been successfully held regularly in Potsdam in cooperation with the European Enterprise Network (EEN). This generates new project ideas and international consortia are established. Closer cooperation has developed with the Drenthe region (NL) in particular, and this will need to be further intensified in the future. The Baltic Sea region, to which Brandenburg belongs in EU macro-strategic terms, also offers starting points for cooperation. Contacts exist here through Cluster internationalisation. In addition to networking regional players, the Bioeconomy Round Table, which has been established since 2017, has created a further platform as a basis for initiating international contacts. The broad spectrum of topics in the bioeconomy is primarily concerned with closing **biogenic value chains**, but also with opening up new value chains. Especially exchange on an international level can generate new ideas and innovations in this regard and strengthen regional companies. So far, only a few players, mainly from the science sector, are present at international level in innovation cooperation. Targeted measures will have to be developed in this respect within the Cluster in future, in particular to systematically increase the proportion of companies.

# 6 Imprint

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**Master Plan for the Cluster Plastics and Chemistry Brandenburg**

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CLUSTER
PLASTICS AND CHEMISTRY
BRANDENBURG

The clusters are supported by
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# OUR GOAL: YOUR SUCCESS!

From green chemistry and biopolymers to innovative composite materials for lightweight construction – the chemical and plastics industry is a strong pillar of Brandenburg's economic structure. The Cluster Plastics and Chemistry Brandenburg is the networking platform for all players in the chemical and plastics industry in the capital region with focus on innovations, cooperations and experts as well as international issues. All companies, scientific institutions and associations are invited to be active partners in the Cluster.

The Cluster Plastics and Chemistry considers itself as a supporting and forcing link between industry and science, networks and interest groups, chambers, politics and public administration in Brandenburg. The Cluster management located at the Brandenburg Economic Development Agency works hand in hand with all Cluster players and sees itself as moderator and initiator with the aim of actively supporting all partners and securing the innovation and competitiveness of the regional economy and developing it further together.

Our services:

- **Identifying innovation and growth potential**
- **Networking and developing cooperation projects**
- **Promoting knowledge and technology transfer**
- **Cluster internationalisation**
- **Identifying and developing synergies with other clusters**
- **Securing and developing of qualified workforce**
- **Active cluster marketing**

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**Wirtschaftsförderung**
**Land Brandenburg GmbH (WFBB)**
Babelsberger Straße 21
14473 Potsdam
www.wfbb.de

Contact person:
Dr. Juliane Epping
Tel.: +49 331 730 61-226
juliane.epping@wfbb.de

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