



SME COMPETITIVENESS AND DIGITAL TRANSFORMATION

*ACCELERATE GDT Workshop SME Competitiveness & Green and Digital Transformation
Fraunhofer-inHaus-Zentrum, Duisburg (Germany)*

Duisburg, 20/07/2023 / Prof. Dr. Daniel Buhr

**What are the key success factors
for SMEs?**





What are the key success factors for SMEs?

- **Innovativeness**
- **Speed**
- **Frequency of innovations**
- Financial base

*“In the current innovation debate, the **speed and frequency of innovations** have been described as critical (Langseth/O’Dwyer/Arpa 2016). Chen, Reilly, and Lynn (2012) argued that speed has become a magical word and that fast decision making, fast internationalization, and fast new product development are embraced as key to **creating the competitive advantages** of firms.”*

(Hilmersson/Hilmersson 2021)

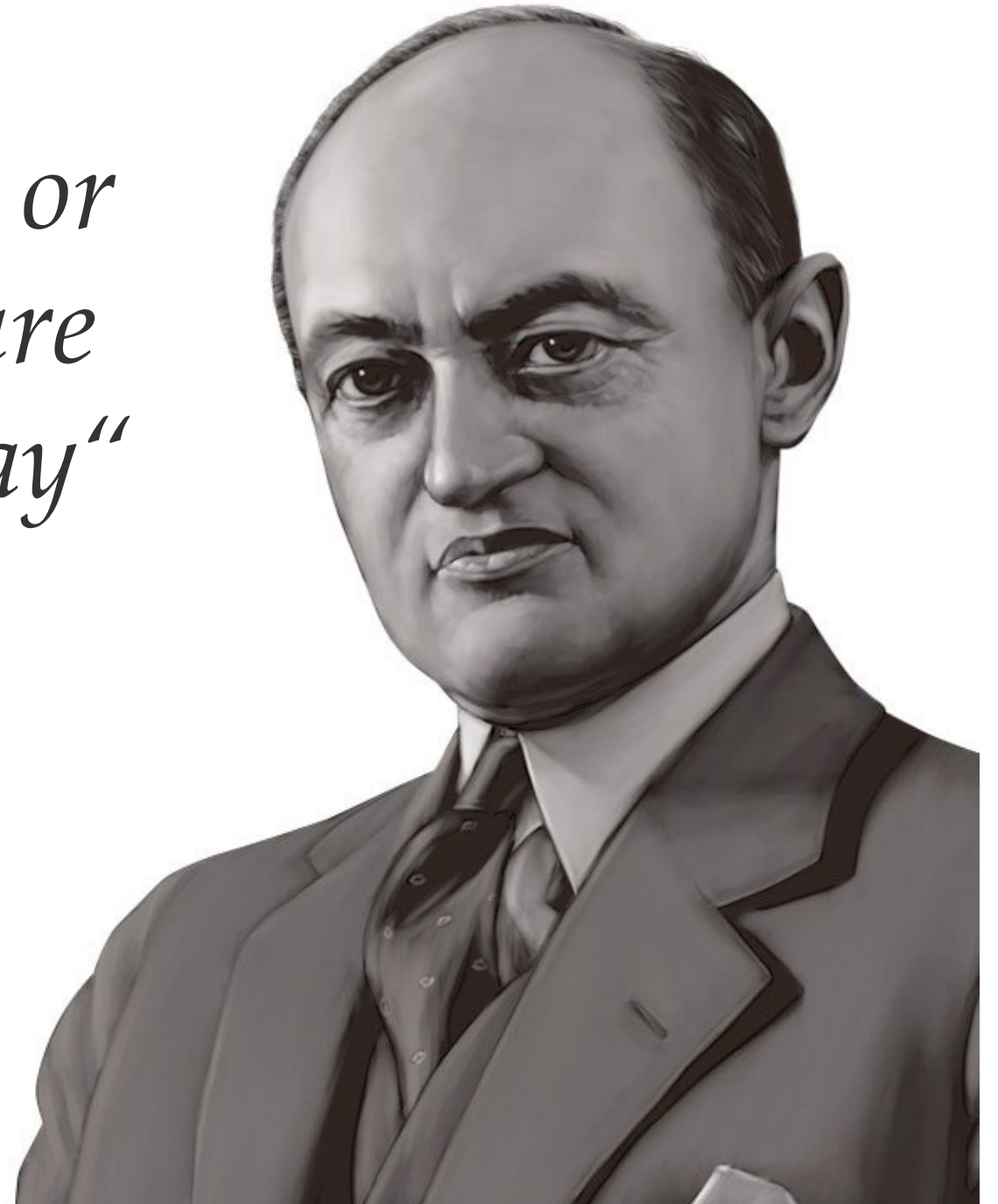
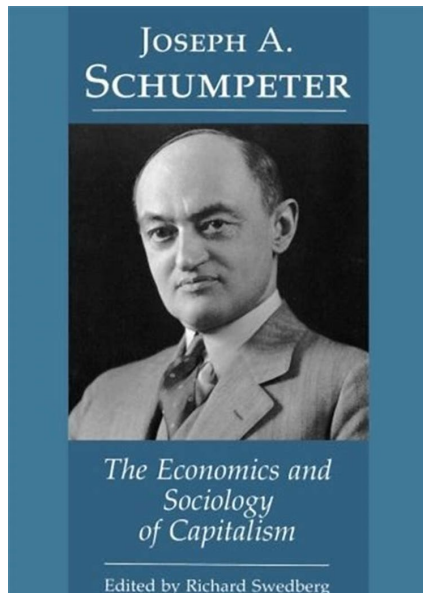


Innovation



Invention Innovation Diffusion

„the doing of new things or
the doing of things that are
already done in a new way“



A close-up photograph of a dinosaur's head, likely a Tyrannosaurus Rex, with its mouth open. The dinosaur's skin is a textured, brownish-grey color. A small, light-colored bird is perched on the lower teeth of the dinosaur's mouth. The background is a clear, bright blue sky. A white rectangular box with black text is overlaid on the center of the image.

INNOVATION NEEDS TRUST.



Trust

Medium and **mechanism for reducing uncertainty and risk** in relationships between collective and or individual actors (Cf. Luhmann).

Personal and systemic trust

Process-based: Arises from long-term stable relationships (e.g., supplier relationships, R&D partnerships)

Property-based: Arises from shared characteristics that are viewed as trustworthy (e.g., local proximity, industry affiliation)

Institution-based: Based on formal social structures (e.g., norms, certificates, social partnership).




Invention Open Innovation Diffusion



Open vs. Closed Innovation

The **closed innovation** model relies primarily on **control**: solutions are developed internally, within hierarchical organizations, patented and then brought to market.

The **open innovation** model thrives even more on **trust**: Solutions are developed in networks, decentralized and in close cooperation and collaboration with other, external actors: suppliers, customers, associations, universities and even competitors.



*„The results indicate that the innovation pace of a firm depends on the **capabilities** developed. By developing innovation capabilities at an early age, firms are likely to drive market changes instead of being challenged by them. Firms that lag in the innovation process can **compensate for this by actively networking for resources and capabilities.**“ (Hilmersson/Hilmersson 2021)*



Most SMEs are more market-driven than research-driven.

*“SME-level innovation often **depends on more intangible factors**, such the quality of the **local regional innovation system** (Parrilli and Radicic, 2021). **Collaboration and networking**, both at the firm and institutional level, are **fundamental for the generation and diffusion of knowledge** at the root of innovation in many SMEs. Innovation in SMEs normally happens because of a myriad of collaborations that involve science and technology agents (**STI**) as well as those based on learning-by-doing, using and interacting (**DUI**) (Jensen et al., 2007).”* (Hervas-Oliver et al. 2021)



“The value of an idea lies in the using of it.”

Thomas Edison (1847 – 1931)



Regional heterogeneity and SME innovation

Different industrial settings and knowledge bases in regions directly influence how local firms innovate (Hervas-Oliver et al. 2021):

- **Analytical knowledge base:** settings where scientific knowledge is highly important, firms develop R&D activities, and interact with universities. This case is typically found in advanced regions with a high endowment of IT, biotech, or other advanced industries.
- A more **synthetic knowledge base** refers to industrial settings where innovation takes place mainly through problem-solving, non-R&D activities, and knowledge embodied in machinery and equipment, with an intense interaction process along the supply chain (customers, suppliers, competitors). In this setting **tacit knowledge** becomes crucial and it is recombined through **learning-by doing, by-using, and by-interacting**. This is typically encountered in intermediate or peripheral regions with a high presence of low-tech or traditional industries. => **hidden/neglected innovation**
=> *They become strongly dependent on their regional innovation systems to achieve any type of innovation, as they often lack of in-house R&D capabilities.*



Regional settings and modes of innovation I

According to literature (i.e. Hervas-Oliver/Parilli/Rodriguez-Pose/Sempere-Ripoll 2021) two main forms of promoting innovation exist:

1. the first is based on exhaustive investment in R&D, scientific human capital, and infrastructure (**STI, for science and technology-based innovation**); (*this is where the 3% fetish is coming from*) => INVENTION
2. the second on learning-by-doing, by-using and by-interacting (**DUI**). => DIFFUSION



Regional settings and modes of innovation II

In many areas of Europe factors such as doing, using, and interacting (the DUI mode) represent the main mode of innovation for SMEs. DUI depends on iterative and interactive practices and learning-by-doing within the firm as well as along the supply chain (suppliers, service providers, and clients).

In other places, by contrast, the STI mode is a better predictor of innovation at firm level. The latter mode, however, requires more advanced knowledge and highly skilled/scientific staff that work within R&D departments and that interact relatively little with other departments of the company (e.g., procurement, production, marketing, logistics). This model also relies on collaborations with scientific partners (universities and technology centres).



SMEs in more innovative regions...

“...will more likely adopt a scientific/analytical and codified approach to knowledge, implying a more intense use of R&D-based activities —and particularly private R&D— driven by a higher accessibility to financial and infrastructural resources, a greater capacity to exploit private research efficiently (vis-à-vis public R&D), a more highly qualified human capital, and a greater overall absorptive capacity (Cohen and Levinthal, 1990; Zahra and George, 2002).

⇒ high-technology clusters and regions, such as Medicon Valley in Denmark/Sweden, Cambridgeshire and Baden-Württemberg, amongst others.

In these advanced innovative regions, the interactive pattern is especially focused on promoting collaborations with science- and technology-oriented actors (universities and research labs).

In general, these regions produce the most innovative ecosystem for SMEs.” (Hervas-Oliver et al. 2021)

SMEs in less innovative regions...

“...are, according to recent evidence (Rodríguez-Pose and Wilkie, 2019; Parrilli et al., 2020; Rodríguez-Pose et al., 2021), less likely to benefit from R&D activities.

SMEs in these regions will rely on inter-firm collaboration to exchange tacit and synthetic knowledge, and to learn collectively by-doing, by-using, and by-interacting with similar agents (Lundvall, 1992; Apanasovich et al., 2016).

This approach can also generate a positive impact on innovation performance (Thoma, 2017).

This would imply a less intensive adoption of scientific and technological interactions and, therefore, a lower influence by universities and scientific labs on the innovation performance of SMEs than in core areas.

Weaker human capital and technology infrastructure endowments will also limit the capacity to innovate of SMEs in these areas (Parrilli et al., 2016; 2020).” (Hervas-Oliver et al. 2021)



Human capital
Complexity capital

Innovation Capability

Structural capital
Relational capital



Innovation Capability (IIT 2018)

Human Capital	Well-educated workforce is a key factor for innovation capability; i.e. qualification levels of formal and informal education and training.	} Stock of knowledge
Complexity Capital	The diversity of knowledge that enables the development of complex solutions.	
Structural Capital	internal structures and processes bringing together the heterogeneous knowledge that is distributed within an organization	} Combination of knowledge
Relational Capital	The ability of an organization to acquire and combine knowledge is also affected by its external relations, i.e. its relationships to external partners.	



*„Innovation arise in systems –
and in networks of people.“*



Lundvall's (1992) innovation systems framework: innovation is an interactive learning process that is socially- and territorially-embedded and culturally- and institutionally-contextualized (=> a critique to the linear model that equates innovation capacity with R&D intensity).



SME: Size MattErs.

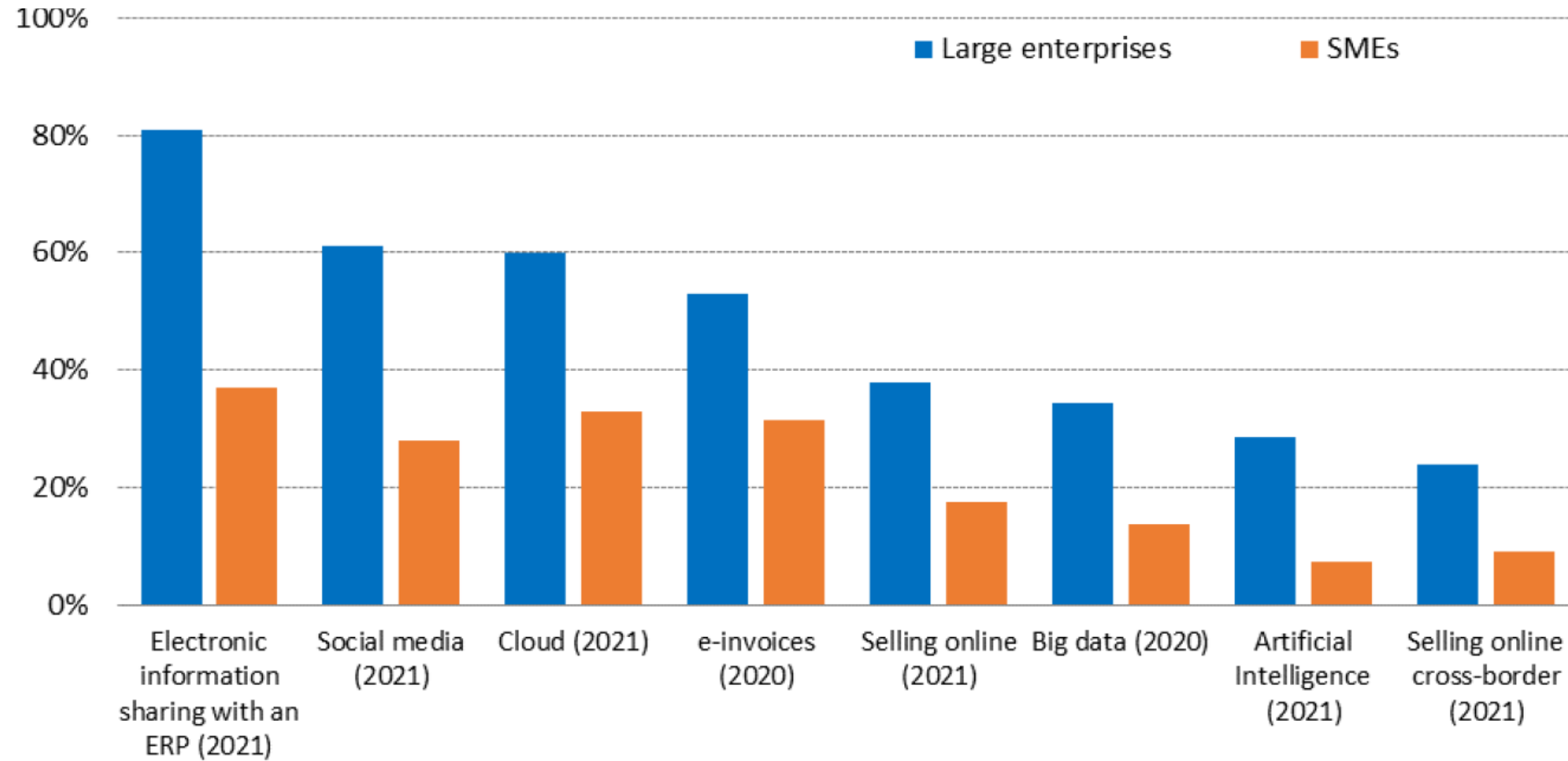
SMEs do not typically have the capacity to invest large sums in R&D departments oriented to produce new knowledge and innovation outputs in-house (Lundvall 1992; Morgan/ Cooke 1998; Asheim/Gertler 2005).

SMEs are particularly dependent from external networks to access strategic resources, such as knowledge, technology, finance or skills, and to innovate and grow. Networks are also a source of resilience and sustainability. They can take different forms beyond buyer-supplier relationships, reflecting the linkages SMEs develop with their ecosystem through exchanges of products, services, assets, or through open innovation and collaboration. Such networks encompass production networks, knowledge and innovation networks (involving universities and providers of knowledge-intensive business service), and strategic partnerships (OECD 2023).

SMEs are generally locally rooted to a far greater extent than the larger and more footloose multinational companies. Clusters are often needed to create proximity and agglomeration benefits.

And: SMEs are (usually) less digitized than large companies.

Adoption of digital technologies (% enterprises), 2020, 2021

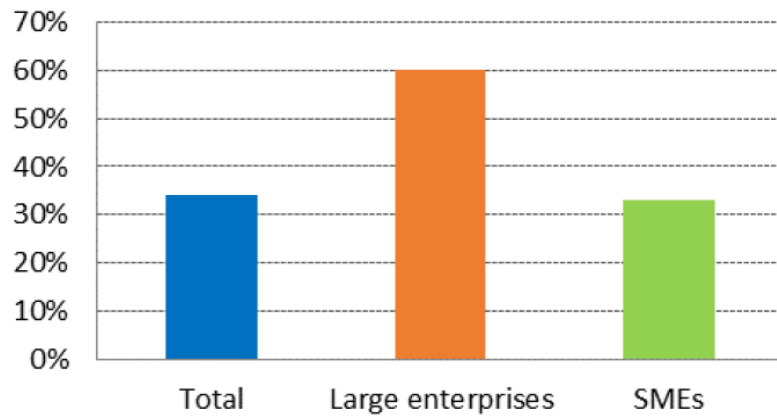


Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.



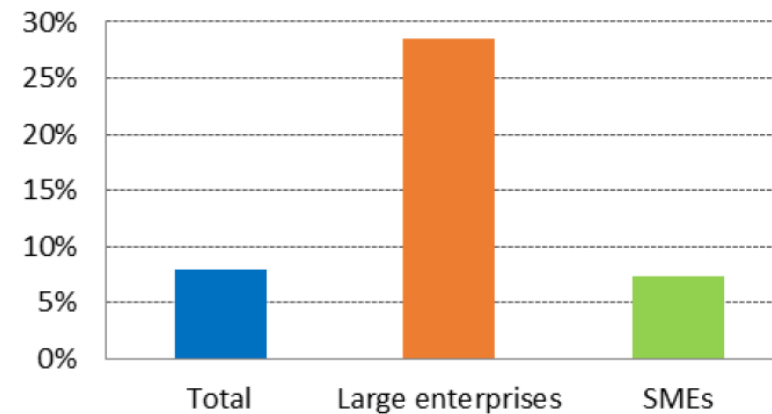
Size matters.

Figure 48 Cloud computing services of sophisticated or intermediate level (% of enterprises), 2021



Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

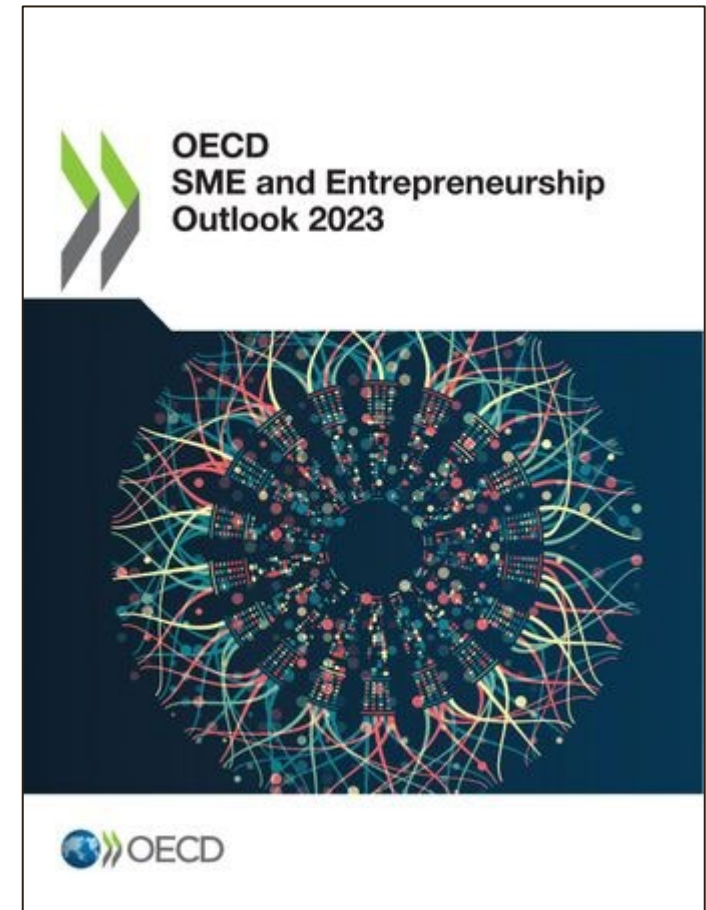
Figure 54 Use of AI technology by enterprise size (% of enterprises), 2021



Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

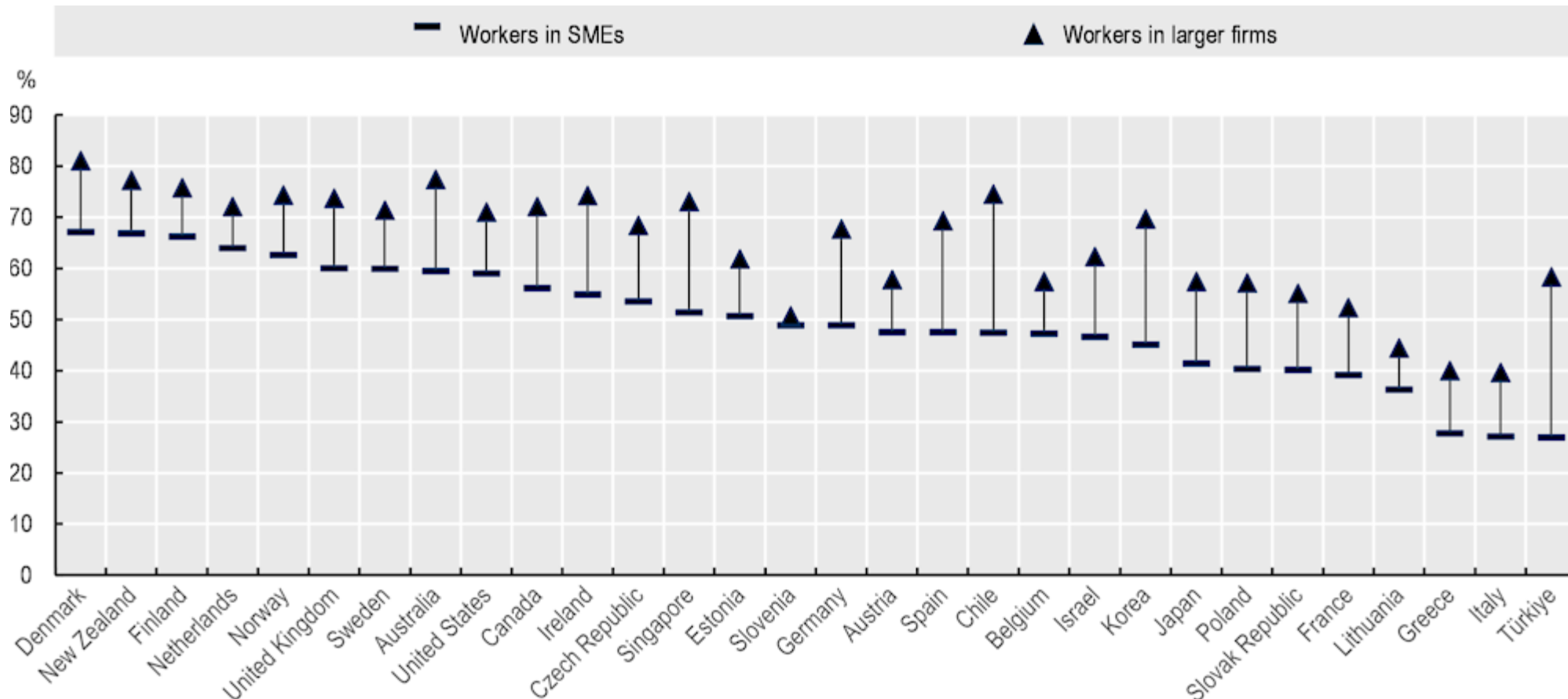


***“SME skills needs
are evolving
rapidly due to the
digital and green
transition.”***



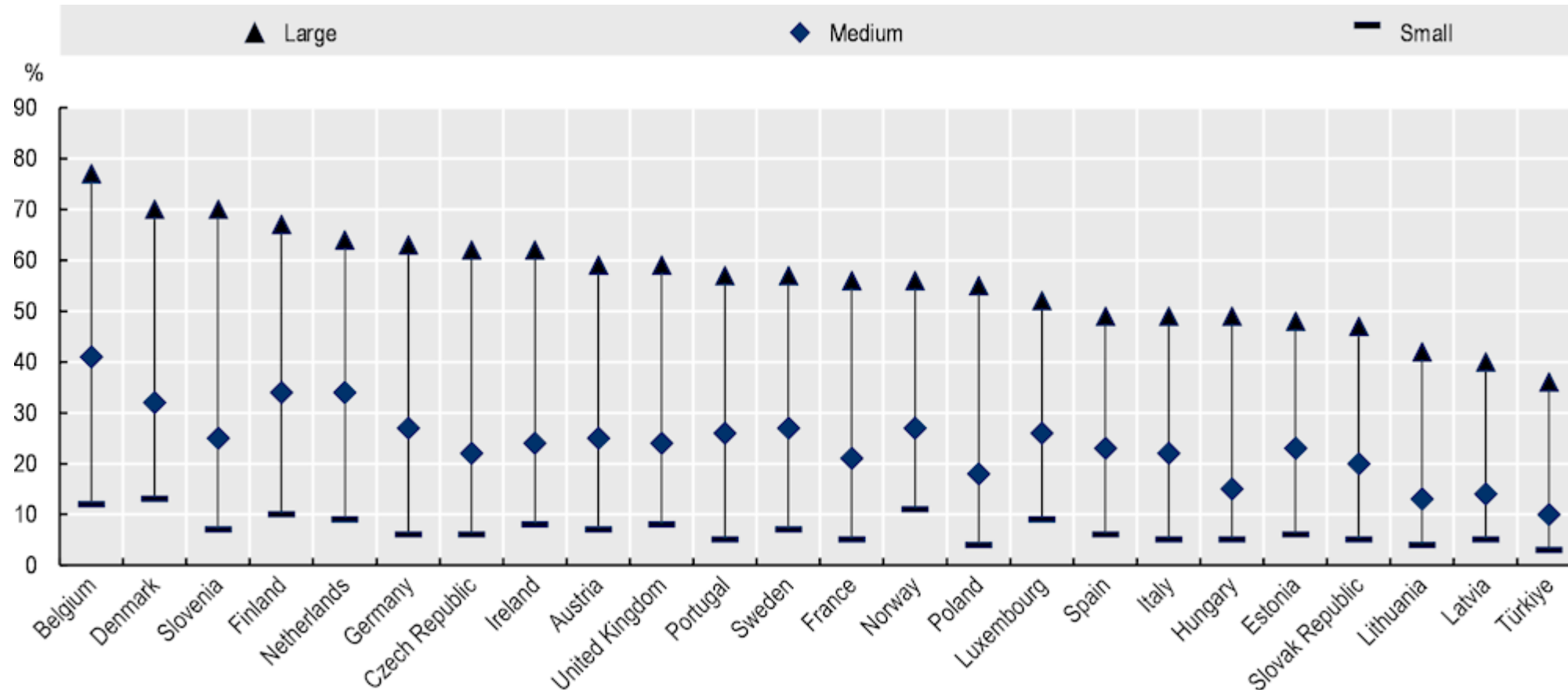
SME employees are typically less involved in formal and non-formal training activities (OECD 2023)

Percentage of adults participating in formal and non-formal job-related learning



Smaller firms offer less ICT training to employees

Share of firms providing training to develop/upgrade ICT skills of their personnel, 2020 (OECD 2023)



Source: Eurostat (2022[39]), *Digital Economy and Society (database)*, <https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/database>.



Conclusion

Innovation is key for competitiveness.

Innovation consists of Invention and Diffusion.

Most SMEs – especially in peripheral regions – follow an innovation model of learning-by-doing, by-using and by-interacting (DUI).

They depend on collaboration in (local) networks – and on skilled employees.

Therefore, a sole focus of innovation policies on the invention phase and R&D (3% goal) is not sufficient. DUI innovation models should be taken into account as well.

This is particularly important for challenges like green and digital transformation in those (peripheral) regions, that are or will be particularly affected by structural change.

Study: Transformationstrategien in particularly affected regions (in Germany)

This study looks at the effects of three key transformation processes in the German economy:

- **Automobile transformation:** the electrification, automation and networking of vehicles. The analysis is limited to the production cluster and thus the manufacture of vehicles and vehicle parts. The target regions are those that are particularly characterized by the automotive industry.
- **Ecological transformation:** the reduction of climate-damaging emissions up to zero-emission targets. Regions with a particularly high concentration of energy-intensive industries and emissions-intensive plants are of interest.
- **Digital transformation:** the organization and control of processes and the development of new business models based on data and data models. The focus here is on regions where the digitization of companies is still not very pronounced.



BAVC

BDA
DIE ARBEITGEBER

BDI
Bundesverband der
Deutschen Industrie e.V.

Bundesministerium
für Wirtschaft
und Klimaschutz

DGB

DIHK
Deutscher Industrie- und
Handelkammertag

EVG

GESAMT**METALL**

G

Industrieunternehmen
Kommunikation

Industriepartnerschaft
Kohlenstoff, Chemie, Energie
SBCI

NGG
GEMINSCHEN

Stahl | Wirtschaftsvereinigung
Stahl

VDA | Zentrum der
Automobiltechnik

VDMA

Verein der
Chemischen Industrie e.V.
für gesunden Wohlstand
VCI

ZVEI:
Die Elektroindustrie



Study: Transformationstrategien in particularly affected regions (in Germany)

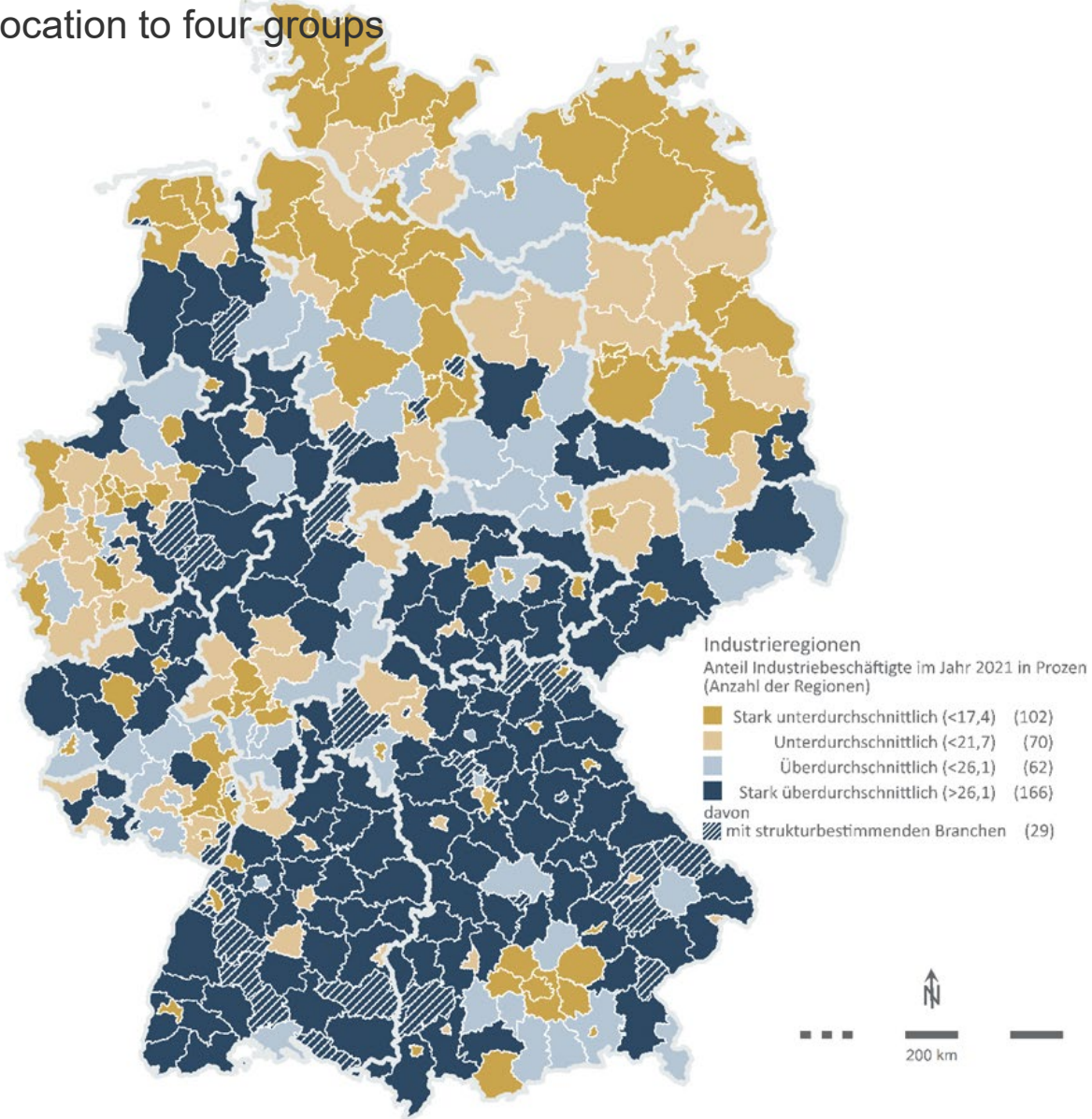
The study

- analyses all 400 districts/counties (“Stadt- und Landkreise”) in Germany
- identifies the regions that are particularly affected by structural changes in automotive industry, ecology and decarbonization, as well as digital transformation,
- evaluates them within the framework of a strengths/weaknesses analysis,
- examines selected regional transformation networks
- identifies specific network types, systematizes them, and
- derives recommendations for an improved funding strategy



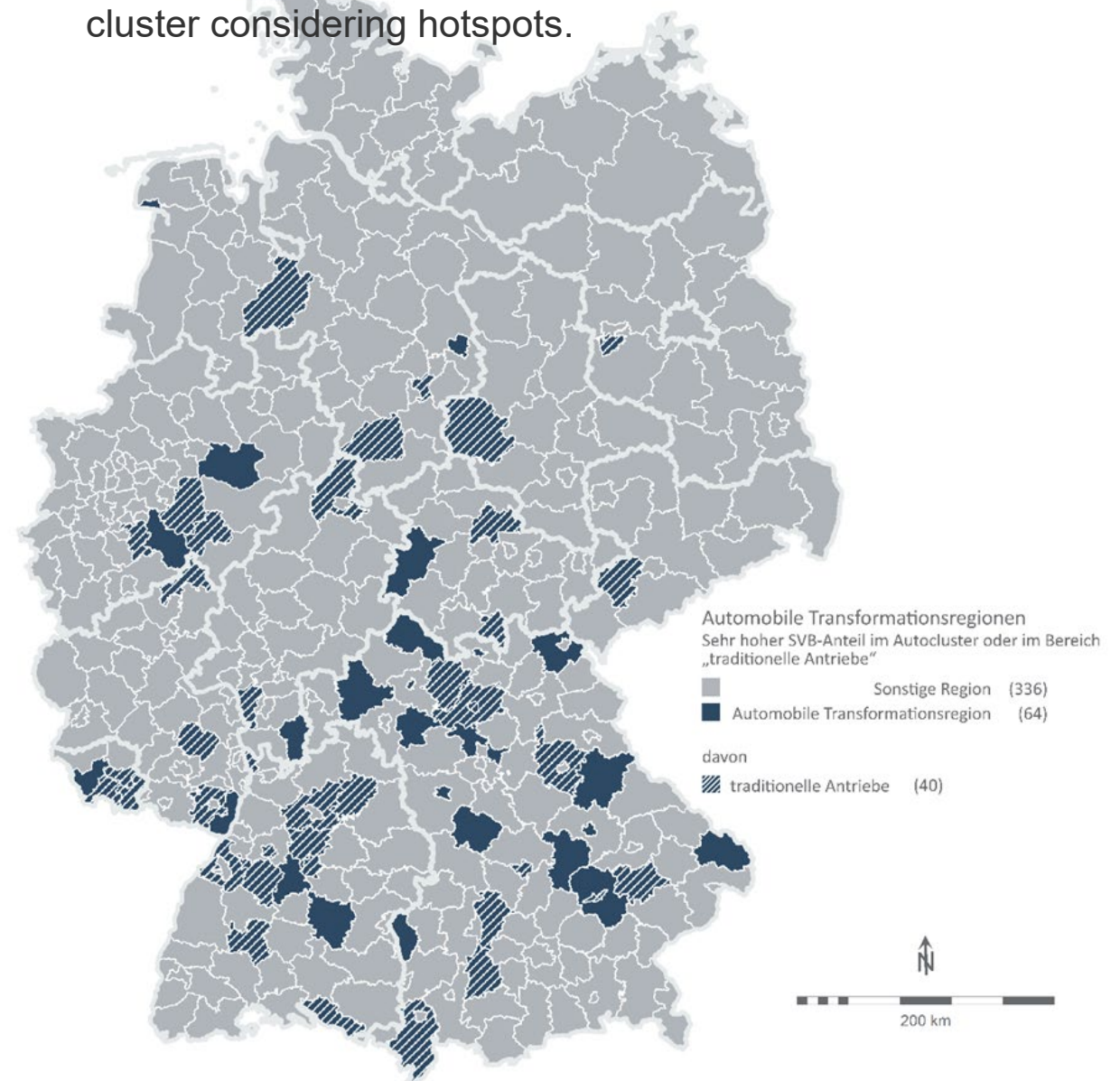
Industrial regions

Proportion of industrial employees in 2021
allocation to four groups



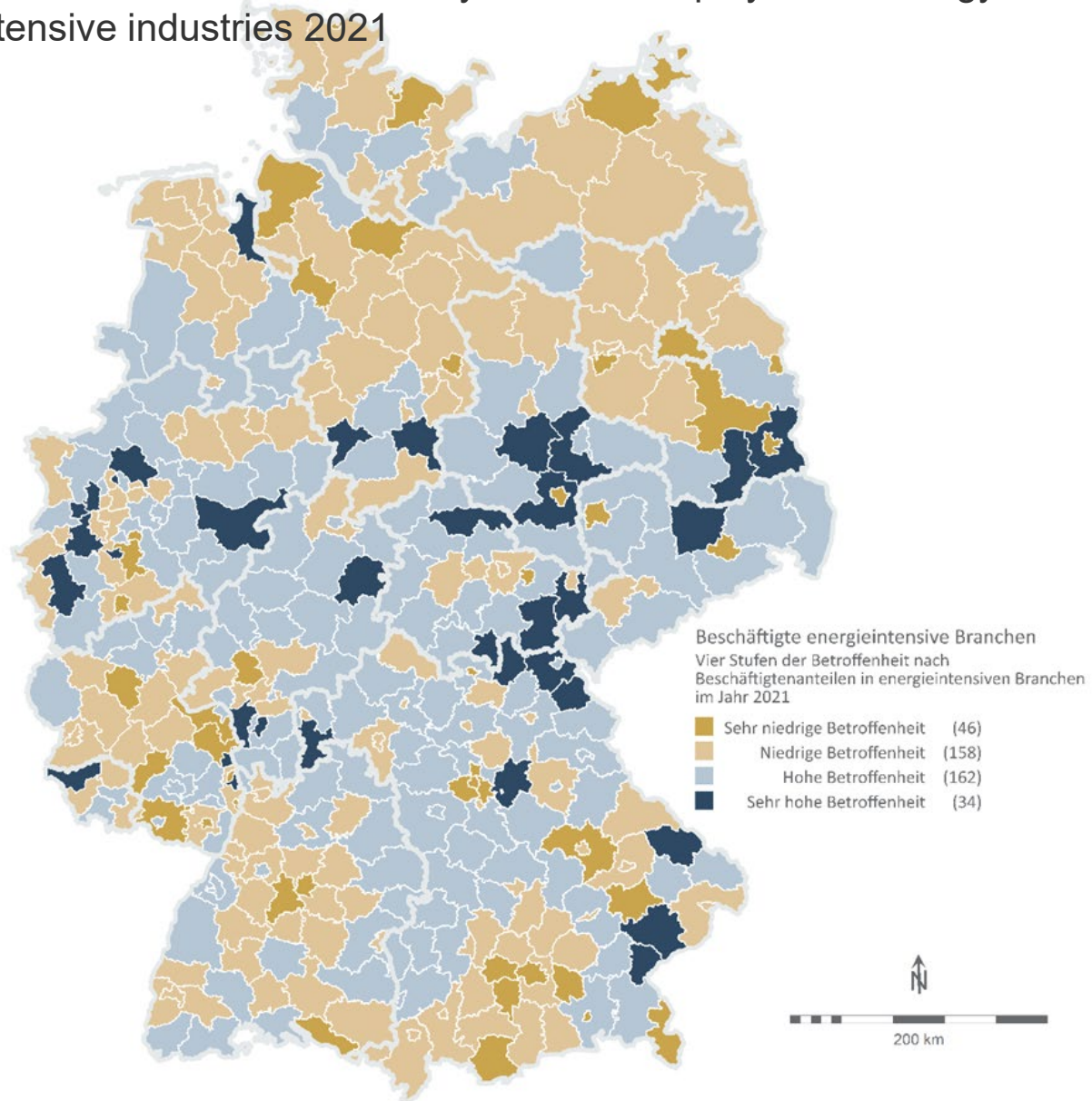
Automotive transformation regions

Particularly high SRP shares in the auto
cluster considering hotspots.



Employees in energy-intensive industries

Four levels of affectedness by share of employees in energy-intensive industries 2021



Regions particularly affected by ecological change

Industrial sectors that are particularly energy-intensive are:

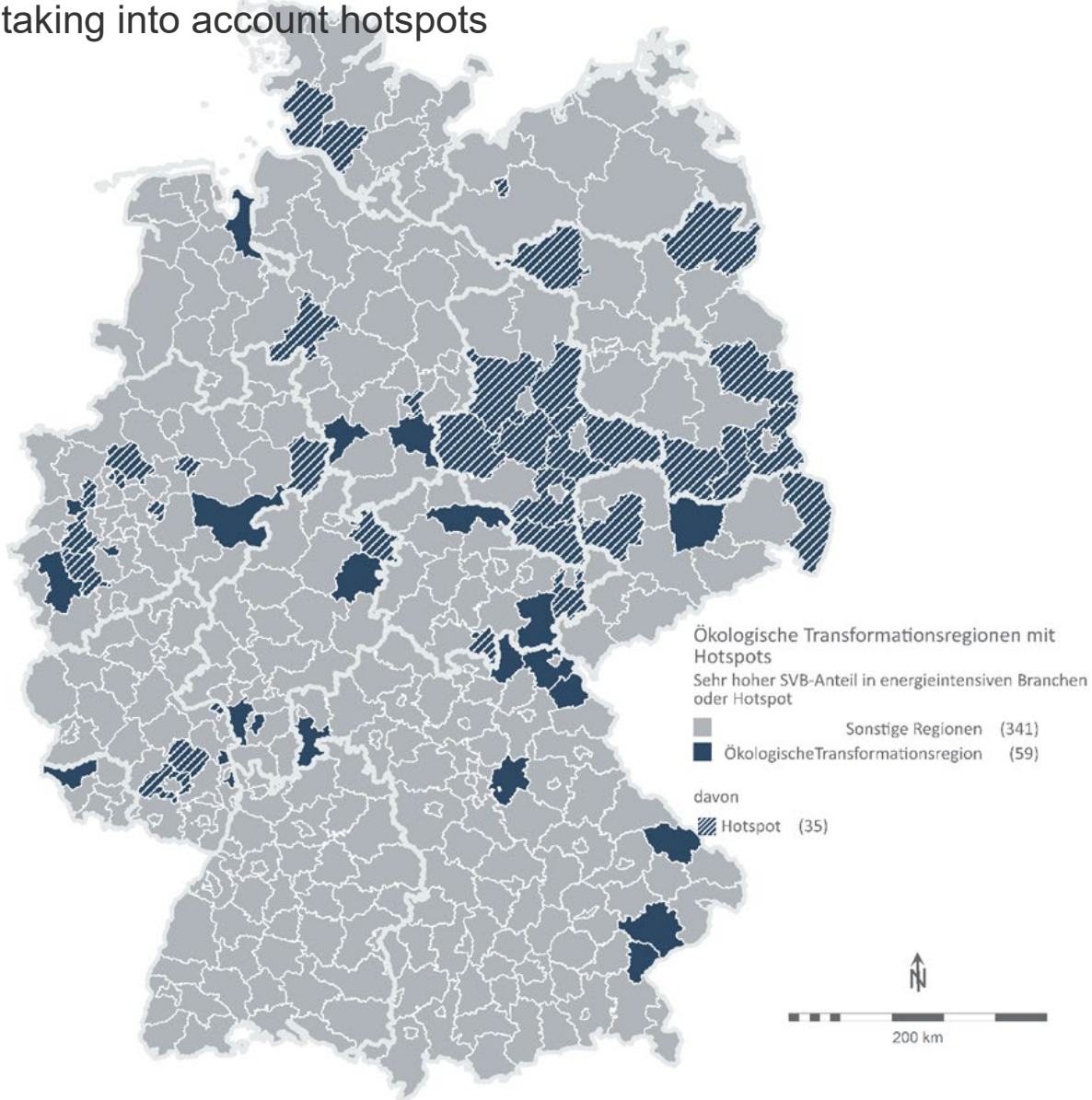
- Coal mining (WZ 05)
- Ore mining (WZ 07)
- Extraction of stone and earth, other mining (WZ 08)
- Manufacture of textiles (WZ 13)
- Manufacture of wood and of products of wood and cork (WZ 16)
- Manufacture of paper and paper products (WZ 17)
- Manufacture of coke and refined petroleum products (WZ 19)
- Manufacture of chemicals and chemical products (WZ 20)
- Manufacture of other non-metallic mineral products (WZ 23)
- Manufacture of basic metals and fabricated metal products (WZ 24)
- Energy supply (WZ 35)
- Collection, treatment and disposal of waste; recovery (WZ 38)
- Removal of environmental pollution and other disposal (WZ 39)

On average, 4.8 percent of all employees can be assigned to these industries.

- 34 regions with a share of more than 9.6 percent (very high impact)
- 162 regions with a share between 4.8 percent and 9.6 percent (high affectedness)
- 158 regions with a share between 2.4 percent and 4.8 percent (low affectedness)
- 46 regions with a share of less than 2.4 percent (very low affectedness).

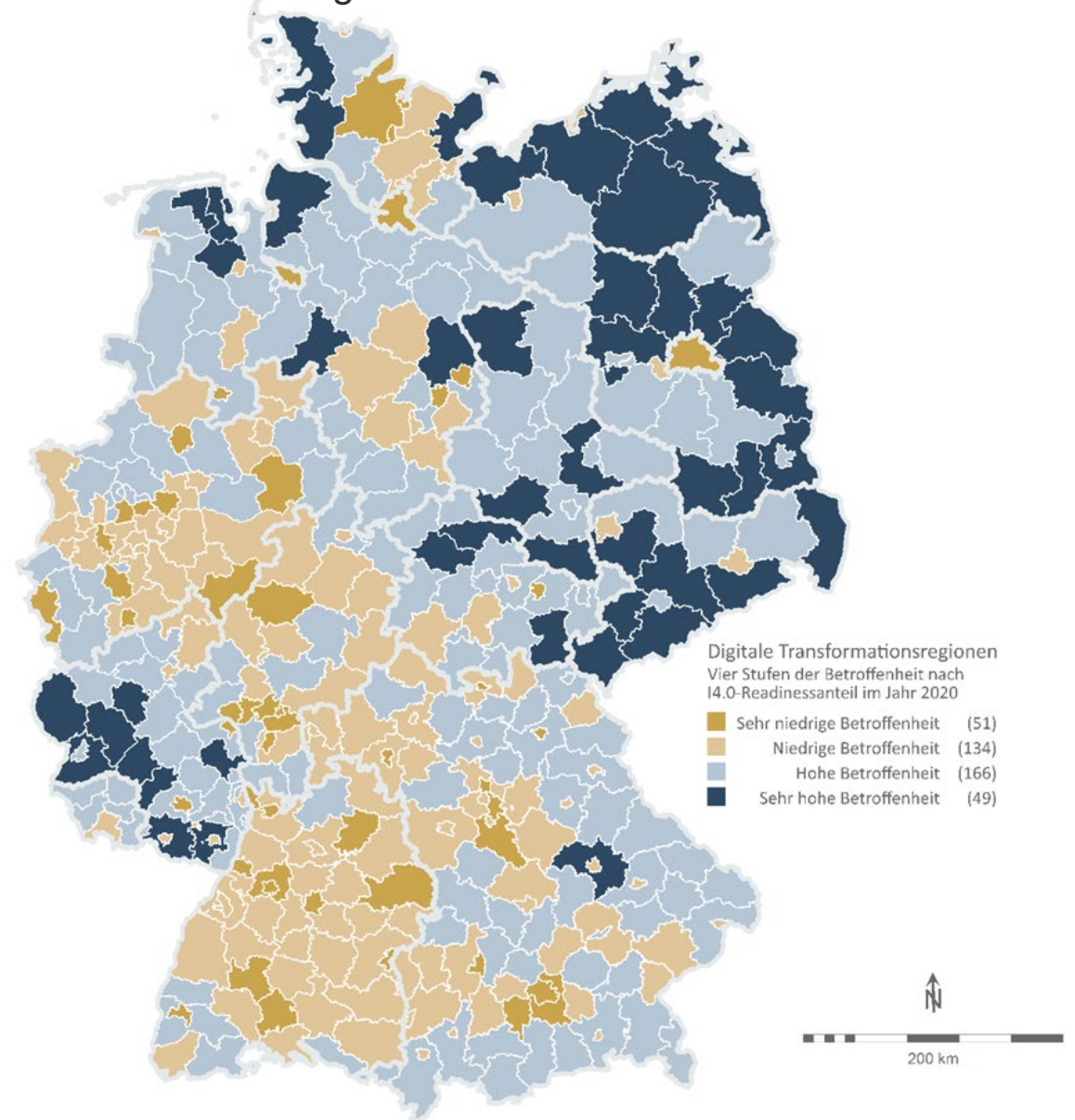
Ecological transformation regions

Particularly high shares of SRP in energy-intensive industries, taking into account hotspots



Regions particularly affected by digital transformation

Classification of regions into four levels of affectedness*



*Regions with the **lowest** shares of I4.0-savvy companies are classified as "very highly affected".



Typification of affected regions

All 400 regions in Germany are initially typified according to two dimensions:

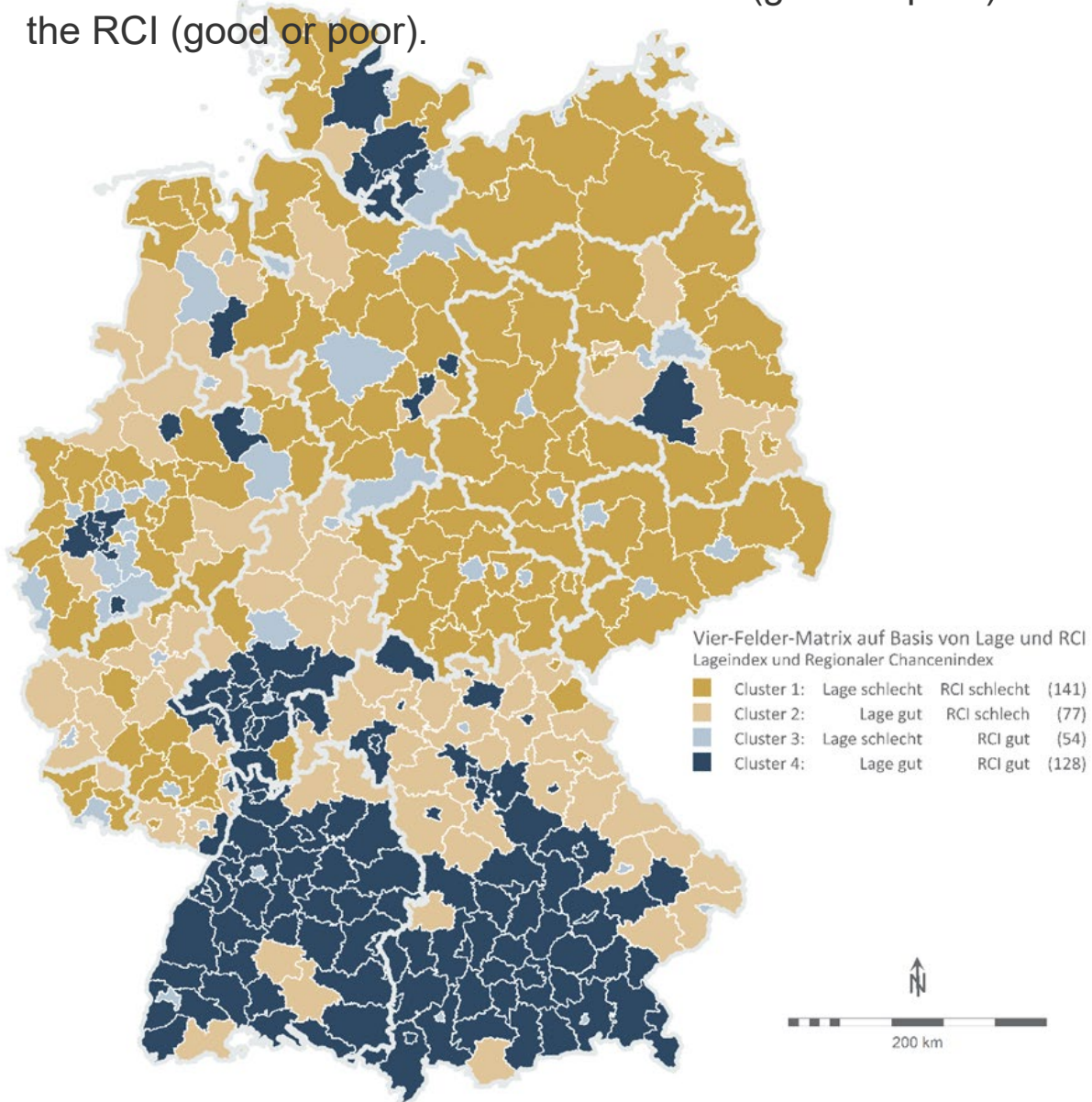
- location
- future opportunities

For both dimensions, an index with several individual indicators is calculated for each region:

- Productivity and the unemployment rate are included in the situation index.
- The regional opportunity index (“Regionaler Chancen Index” RCI) takes into account knowledge, industry structure and growth environment, demographics as well as infrastructure and attractiveness. In total, the index consists of 30 individual indicators.

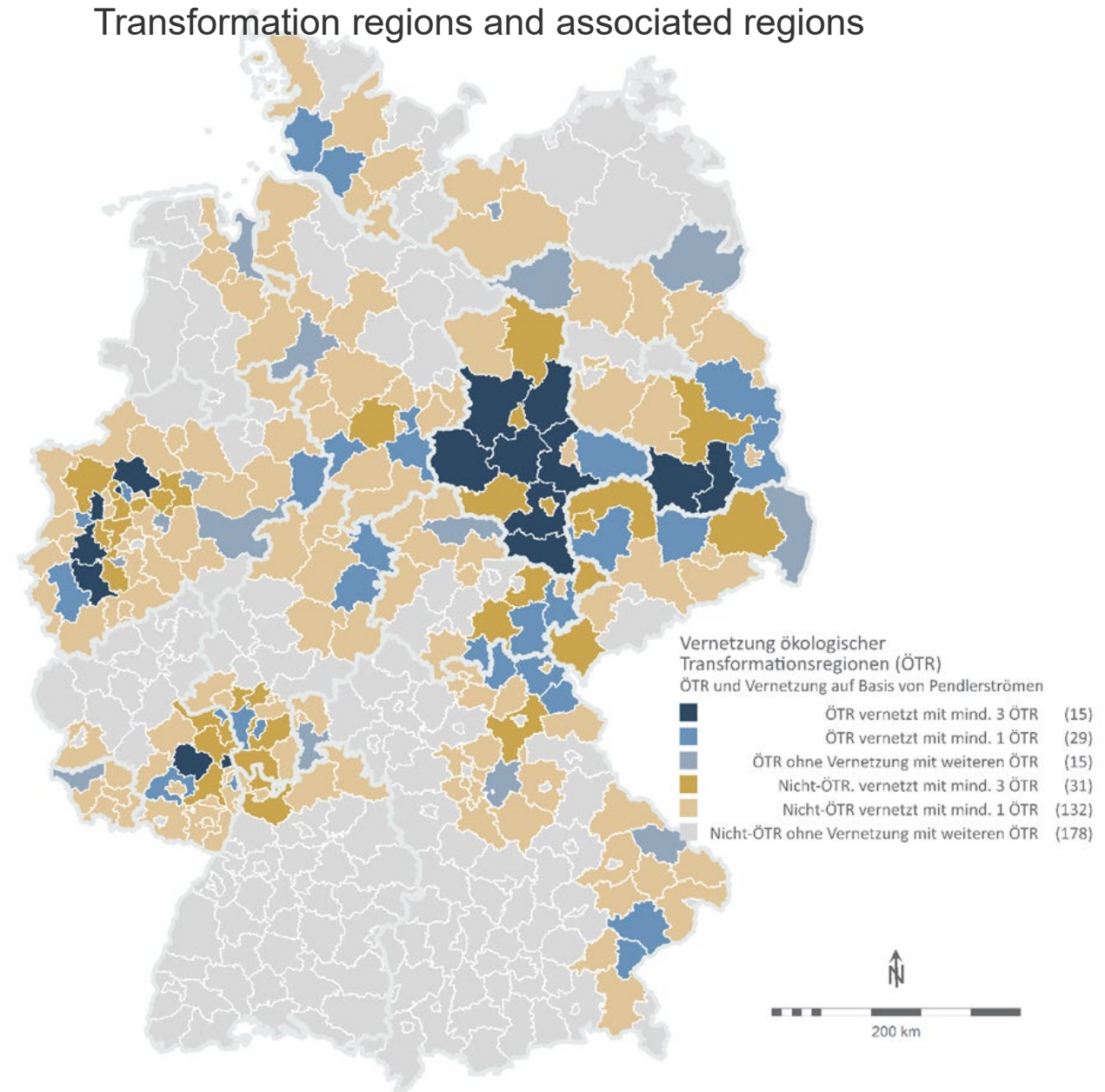
Regions by location and regional opportunity index

Four clusters based on the location index (good or poor) and the RCI (good or poor).



Regional networks in the energy-intensive cluster

Transformation regions and associated regions





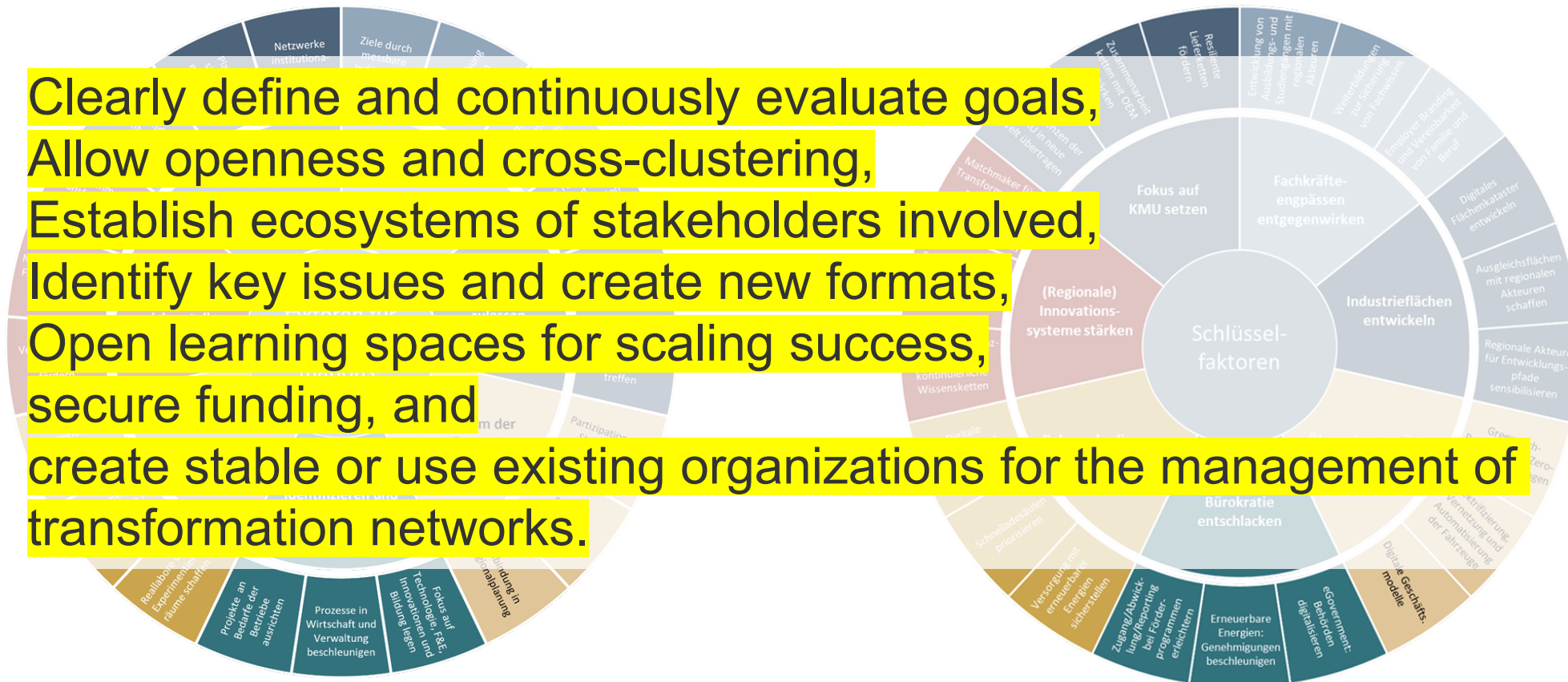
Policy recommendations.





Policy recommendations.

- Clearly define and continuously evaluate goals,
- Allow openness and cross-clustering,
- Establish ecosystems of stakeholders involved,
- Identify key issues and create new formats,
- Open learning spaces for scaling success,
- secure funding, and
- create stable or use existing organizations for the management of transformation networks.





Thank you.

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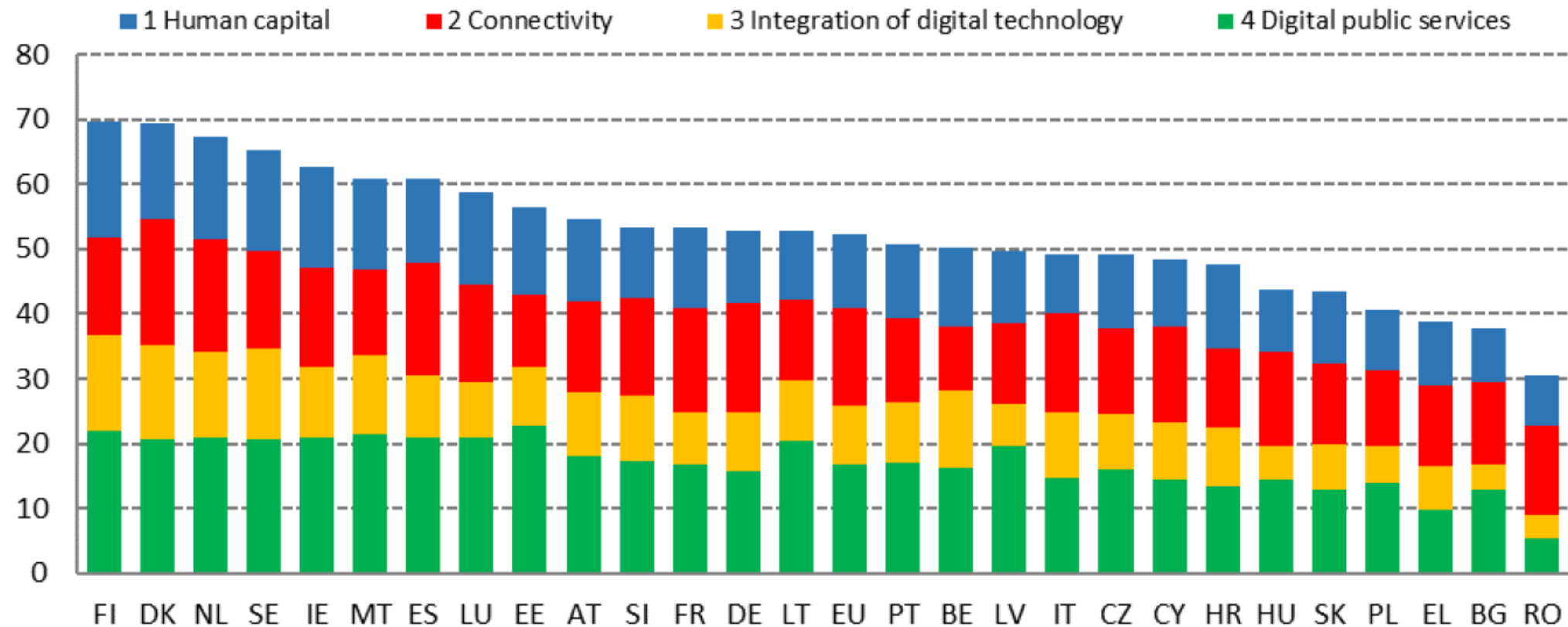
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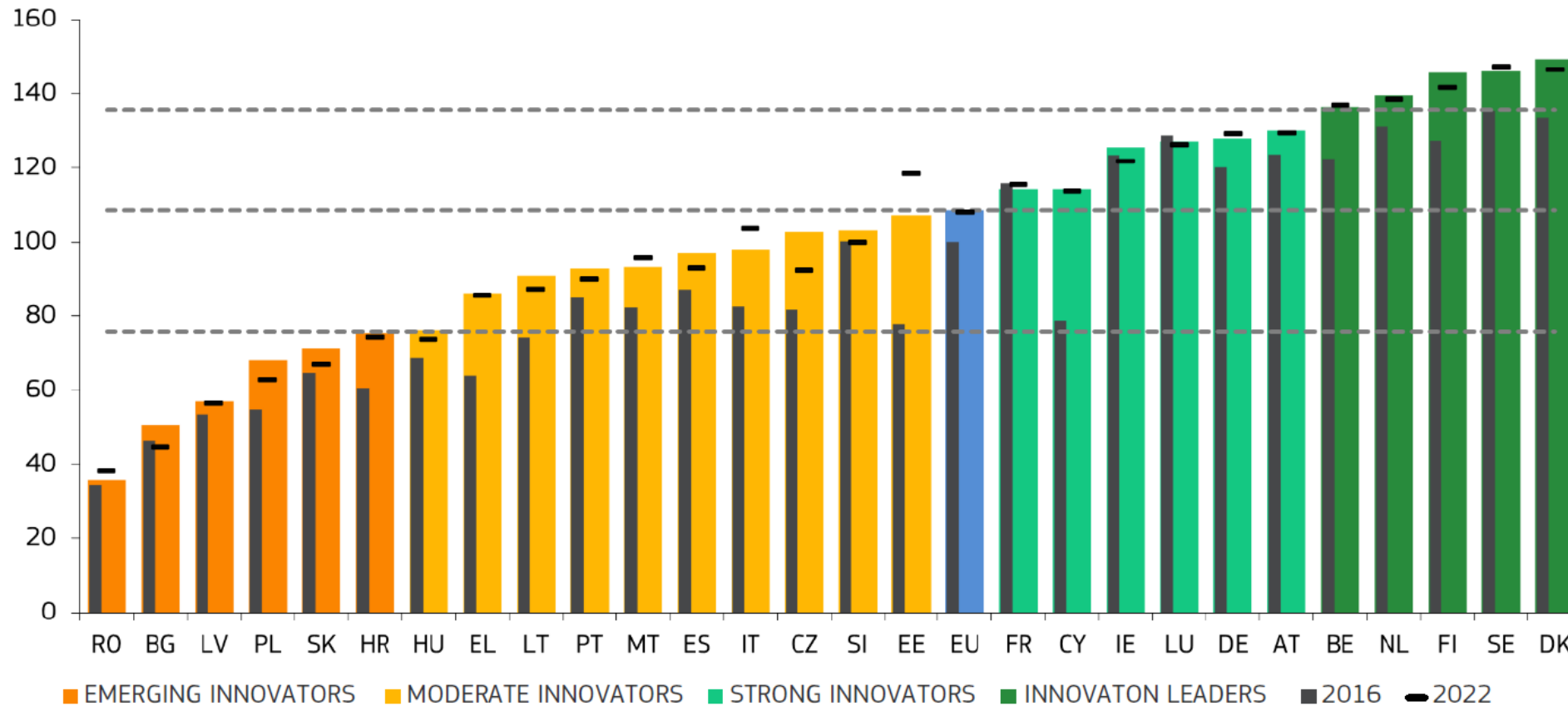
Digital Economy and Society Index 2022



Source: DESI 2022, European Commission

European Innovation Scoreboard 2023

Figure 1: Performance of EU Member States' innovation systems



<https://op.europa.eu/en/publication-detail/-/publication/5d1b30d5-1ba9-11ee-806b-01aa75ed71a1/language-en/format-PDF/source-289021440>



European Innovation Scoreboard 2023

https://ec.europa.eu/assets/rtd/eis/2023/ec_rtd_eis-country-profile-de.pdf

GERMANY is a Strong Innovator with performance at 117.8% of the EU average. Performance is above the average of the Strong Innovators. Performance is increasing at a rate lower than that of the EU (8.5%-points). The country's performance lead over the EU is becoming smaller.

Relative strengths

- Public-private co-publications
- Doctorate graduates
- Employment in innovative enterprises
- Business process innovators
- Innovation expenditures per employee

Strong increases since 2022

- Enterprises providing ICT training
- Broadband penetration
- Resource productivity

Relative weaknesses

- Government support for business R&D
- Lifelong learning
- People with above basic overall digital skills
- Population with tertiary education
- Venture capital expenditures

Strong decreases since 2022

- Product innovators
- Design applications
- Innovative SMEs collaborating with others