



**CORDUS**  
CORDUS

# Structural Transformation in Industry and Economy

German Experiences

# Structure

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## The German Research Landscape

The Federal Government uses a number of different instruments in funding R&D, the most important are

- *direct project funding*
- *Indirect basic funding of institutional research*

Direct project funding is always provided for a concrete field of research. The purpose of such funding is to achieve high international standards of performance in selected areas of research and development.

The aim of indirect project funding is to support research institutions and business enterprises – especially small and medium-sized enterprises (SME).

## Science-Promoting Foundations

### The German Research Society (DFG)

The DFG is the central self-governed organization of German science. The main task of the DFG is to support research at universities and public research institutions, although most of its resources go to the university sector. In 2008 the DFG more than 20,000 projects with 1,6 Billion Euros.

### The German Federation of Industrial Research Associations “Otto von Guericke” (AiF)

As a self-governed organization of the business enterprise sector, the AiF aims to support applied R&D to the benefit of Small and Medium-sized Enterprises (SMEs). The AiF's work includes both sector-wide and company-specific activities, as well as activities oriented to universities of applied sciences. The budget for research grants is approximately 300 Million Euros annually.

## Science-Promoting Foundations

### The German Foundation for the Environment (DBU)

The DBU emphasizes development of innovative practically oriented solutions especially in the areas of product-integrated and production-integrated environmental protection: climate protection via energy efficiency and technological optimization of renewable energies, development of resources-efficient construction projects; sustainability-oriented chemical products and processes; and biotechnological products and processes. It does not fund basic research. The total annual budget for research grants amounts to approximately 44 Million Euros.

Other large German foundations such as the Volkswagen Foundation, the Thyssen Foundation, the Robert Bosch Foundation and the Bertelsmann Foundation also sponsor projects or institutions throughout a wide variety of scientific fields.

## Universities

- are the backbone of the German research system
- second largest R&D sector after the industry (in terms of total expenditure)
- Research ranges from basic research to applied research and the development of new materials, processes, systems as well as services and their improvement.

### Universities of applied sciences (established at the beginning of the 1970s)

- increasingly important role in application- oriented R&D
- practical orientation
- important link between the science and business communities
- “natural” partners for businesses in their regions, especially SMEs without R&D departments of their own.

## Excellence Initiative

In 2006 the government established the Excellence Initiative. The best of the best are to be found in the competition among 319 universities.

An international, independent jury consisting of members of the German Research Foundation (DFG) and the Science Council selected from this pool the best. Nine selected universities got a total budget of 1.9 billion Euros for the promotion of young scientists, the cooperation of universities and scientific organizations in specific disciplines, and finally the promotion of "university research".

## The Max Planck Society (MPG)

- most important research institution, which is responsible for basic research
- Maintains 80 research institutes, research agencies, laboratories and working groups.
- cutting-edge basic research in the areas of biomedical research, chemical, physical and technical research and the humanities.
- In the worldwide ranking first in the fields of chemistry, physics, space sciences and materials sciences (16 Nobel Prize winners among its ranks since 1954)
- In the fields of biology, molecular biology, microbiology, genetics and biochemistry third-, fourth- and sixth-place
- enjoys a high degree of autonomy as a result of the high level of basic financing it receives from the Federal Government- about one billion Euros a year.

## **Displays to roll up, linen with chips and of course MP3 - the Fraunhofer- Society**

- At the Fraunhofer-Society it's all about applied research. The most famous idea in recent times: the MP3 format.
- 58 research institutes, 12,500 people, annual budget of 1 Billion €
- 90 % of its annual research volume is financed by contract research for industry, service-companies and the public sector.
- translating research findings into new and innovative products, processes and services.
- strategic research in spheres of major public interest and in key technologies including information and communications technologies, life sciences, microelectronics, surface technologies and photonics, production, defence and security research.

## **Future topics from health to space exploration - the Helmholtz-Association**

- the giant of German research centres in terms of research and finance.
- 15 national centres for natural science, technological and biomedical research that operate large-scale equipment, such as particle accelerators and research reactors
- 25,000 employees, annual budget 2.3 billion €
- 65 virtual institutes

In “virtual institutes”, research groups staffed with researchers from both universities and Helmholtz Centres join forces to create internationally known and attractive centres of excellence in important research areas.

## Leibniz Association

- umbrella organization for 84 research centres, which are known as “Leibniz Institutes”
- annual budget of 1.1 billion Euros. (the federal and state government finance 75%)
- Leibniz Institutes are interdisciplinary and combine basic research with a close focus on applications.
- the institutes have national importance in terms of science policy.
- greater diversity than all other research organizations.
- wide range of cooperative relationships, especially relationships with universities, other science organizations and industry
- senior- level scientists teach as professors at neighbouring universities

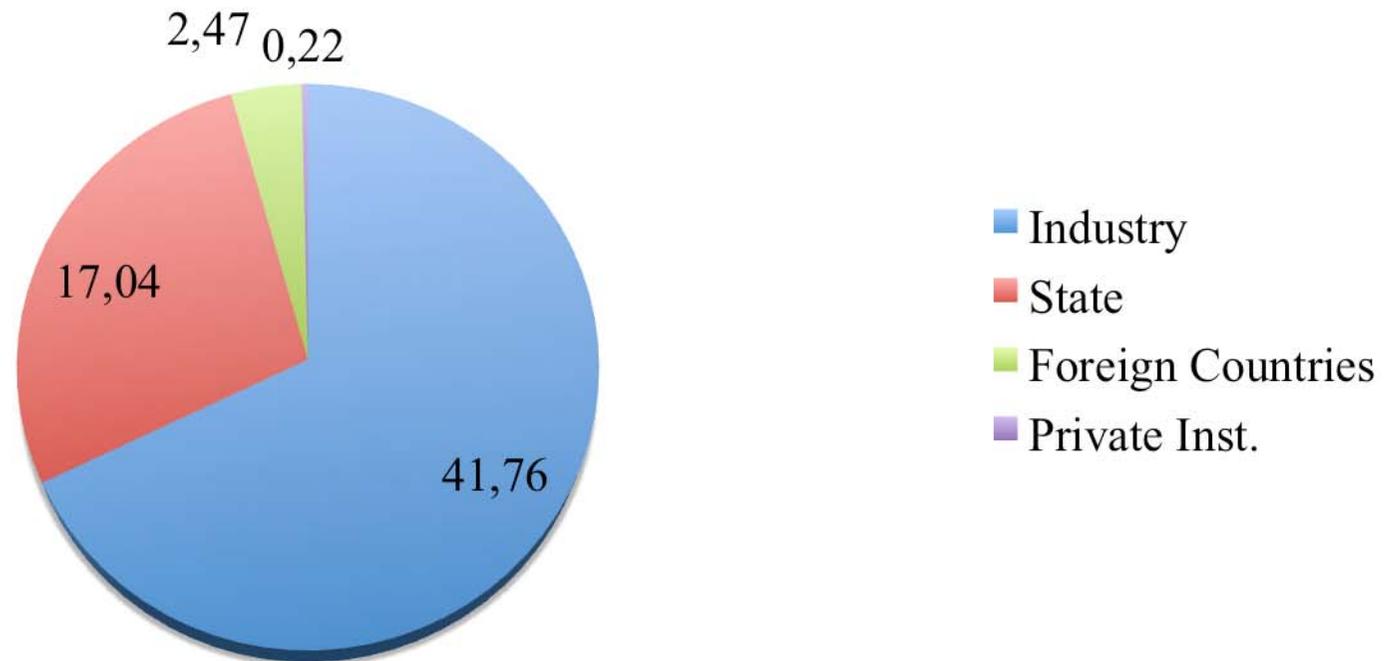
## Other institutions

- 7 Academies of Science, and the federal itself operates
- more than 50 institutions with research tasks operated by the government
- 200 separate institutions with research and development tasks operated by the federal states operate
- as a specialty in East Germany- many R&D GmbH companies, which are mainly financed by industrial contract research.

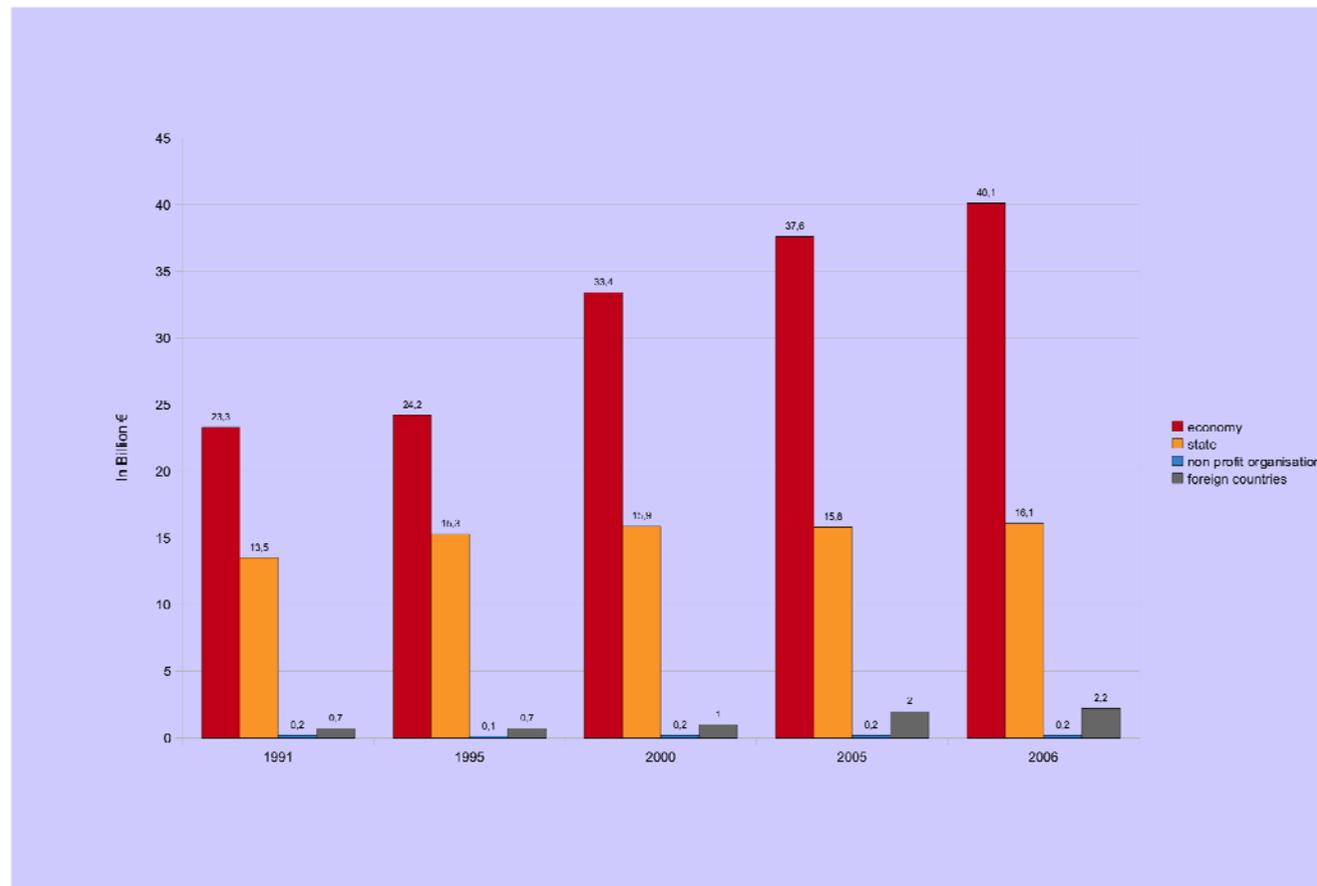
## Industry

- in 2007 the industry financed €41.76 billion or two-thirds of the gross domestic expenditure on R&D, which totalled €59.8 billion
- 92% of total R&D expenditure remains within the industrial sector
- The state provides a total of €3.34 billion for research projects of the enterprise sector
- over 40 % of all industry R&D are for the automotive sector
- 19 % of all industry R&D are for office machines, IT equipment and electrical equipment.
- 17 % of all industry R&D are in the chemical industry
- 9 % of all industry R&D are in the engineering industry

## Funding of R&D in 2007 in Billion €



## Funding of R&D by Different Sectors in Billion €



## **Research Landscape in former GDR (German Democratic Republic)**

- linear system,
- new technologies were developed in centralized scientific institutions
- then passed to the state combines to realize new products and new production methods.
- the scientific institutions of the Academy of Sciences did the application-oriented fundamental research
- Universities were responsible for the academic education
- R&D departments of the companies were responsible for the implementation of new technologies, but not for independent innovations.
- Industrial institutions for applied industrial research as part of the state controlled conglomerates were sometimes responsible for the entire industry sector

## Research Landscape in former GDR (German Democratic Republic)

- technology transfer in one direction without the typical momentum from the demand side for market-based innovations.
- The capacity and willingness of individual scientists and engineers was absolutely given.
- In the 1980s original innovations have been increasingly displaced in favour of the imitation of Western products.
- Competitive inventions (patents) were often sold to foreign countries rather than implemented in own companies.
- In the late 1980s the research and innovation system was oriented in maintaining the existing system rather than on innovation.

## Transformation of Industry in East – Germany

### Actions to survive

- March 1990: Conversion Act (privatization through the Trust Agency)
- unbundling of the remaining conglomerates by management buy-outs or sales to West German and foreign investors
- the conglomerates own research continued as external industrial research facilities known as R&D GmbH
- phase of massive de-industrialization from 1991 until late 1993 (transformation crisis)
- number of persons employed in manufacturing declined by two-thirds
- liquidation of the Academy in 1991 (3,500 people were unemployed)
- massive reduction in industrial R&D (number of industrial R&D employees fell from 86,000 in 1989 to 32,000 in 1993)

# Transformation of Industry in East – Germany

## Actions to survive

- the non-university research was dissolved
- structure of the universities remained unchanged. Some of them have been transformed to universities of applied science.
- the original connections between science and industry have been disbanded.

# Transformation of Industry in East – Germany

## Actions to survive

- granting all staff costs in R&D. "Personnel Support East" and "R & D personnel growth promoting east"
- "Contract R&D East" (introduced in 1990)
- extended in 1991 to R&D contracts from West German companies
- funding of technology-based companies
- establishment of regional technology and business incubators
- funding of single R&D projects,
- funding of orders
- foundation funding

## Transformation of Industry in East – Germany

### Actions to survive

- The bundle of instruments was first especially for the preservation of the R&D departments and R&D personnel, but also to preserve the core of industrial research in East Germany.
- The mission “privatize quickly, rehabilitate resolutely and shut down carefully” came in 1992 under increasing criticism.
- Government decided to obtain "industrial clusters" using additionally the tools of incentives, investment grants and special depreciation models.
- Small- and medium-sized enterprises (SME) got 50% incentives as cash back for all investments (big companies could get up to 30% incentives) and could use special depreciation of 50% in 1year.
- Those programs finally stopped the de-industrialization.

# Transformation of Industry in East – Germany

## Promotion of Cooperation

- in the late 1990s a very powerful R&D landscape had been developed, but the cooperation of companies, research and business-related institutions at the regional level were very rare
- “PRO INNO” the funding of cooperation and collaboration (network) research between industry and / or public research institutions
- "InnoRegio” and “Innovative Core of Growth” the funding of region-oriented innovation programs to promote the innovation potential of entire regions (cluster)
- project funding became increasingly important

# Transformation of Industry in East – Germany

## Network Management

- the network funding (from 2003) became increasingly significant and is today next to the individual and joint project funding an integral part of the funding landscape.
- "Network Management East (NEMO)" supports network activity and formation of clusters
- corporate cluster based on networking relationships and innovative skills: Particularly young, fast-growing industries form clusters like the two clusters of wind energy in Magdeburg and Rostock or the three clusters of the fast growing German photovoltaic industry (PV), which employed in 2008 already 14,000 people

## Formation of Cluster

### Localization phase (1992 to 2001)

- Generic factors are responsible for the settlement in special locations (for the German photovoltaic industry the knowledge in the use of silicon, unemployed professionals and industry-related infrastructure)
- Active settlement policy of the regions. (the promotion of investment had a strong influence on the location decisions of the capital-intensive photovoltaic industry)
- Specialized suppliers were created through diversification of existing businesses in the area of special purpose machines and engineering.
- Governmental market incentive programs (the 1,000-roof program followed by the 100,000-roof program and finally the Renewable Energy Law were the booster of the PV industry)

# Formation of Cluster

## Cluster phase (from 2001)

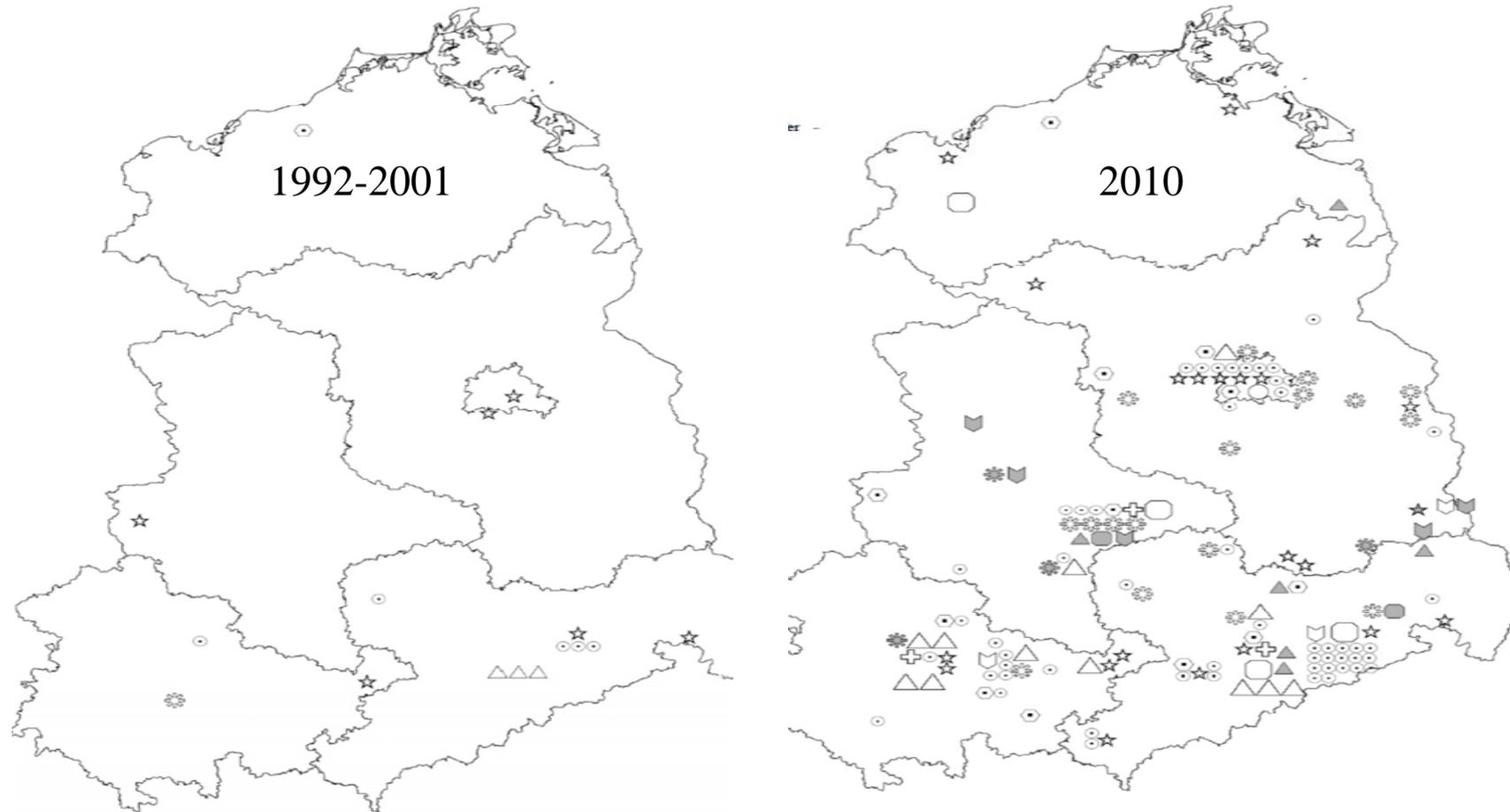
- New companies entered in a second wave the market due to the strong market growth
- The development of new technical solutions (Thin-Film Technology). The different competing technologies attract new PV companies
- Technological diversification generates subsidiaries with different technological directions and form a portfolio that secures the site against technological lock-in effects.
- The companies started to build up affiliates or Joint Ventures
- Vertical integration provides the benefits of cost reduction
- The interaction along the value chain or between different PV technologies leads theoretically to higher productivity, innovation activities

# Formation of Cluster

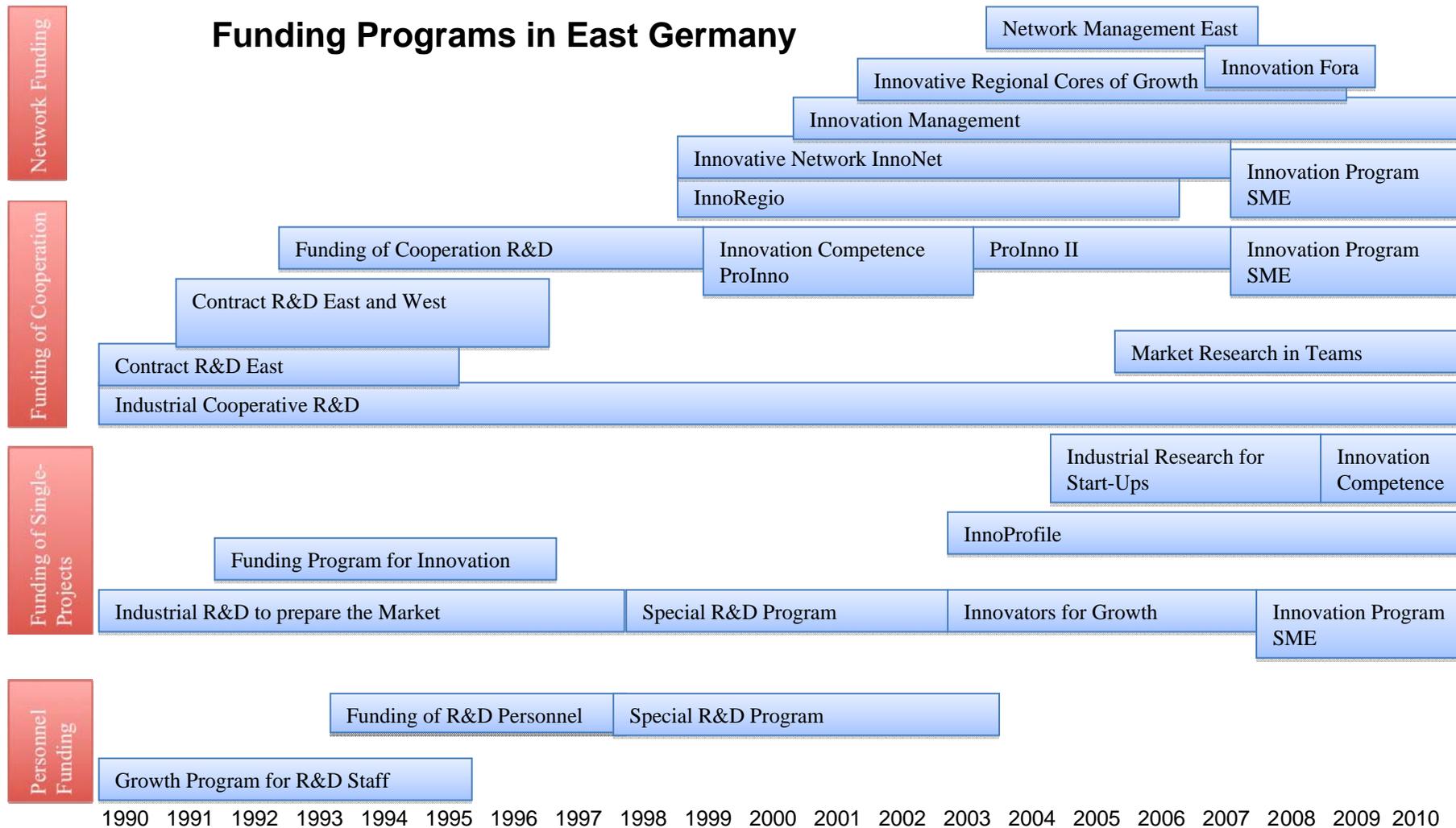
## Cluster phase (from 2001)

- Foreign investors use the increasing attractiveness to set up their manufacturing facilities in already established clusters.
- The increasing market volume is a further strengthening of the vertical dimension of the cluster.
- The forming of regional corporate networks is an element to the development of successful sites.
- The ability of the PV industry to create supportive institutional structures is another aspect of the cluster phase.
- Establishment of training capacity to meet the increasing demand for skilled workers (photovoltaic courses at different Universities)
- The government establishes specialized research infrastructure like the “Fraunhofer Centre for Silicon-Photovoltaic CSP”

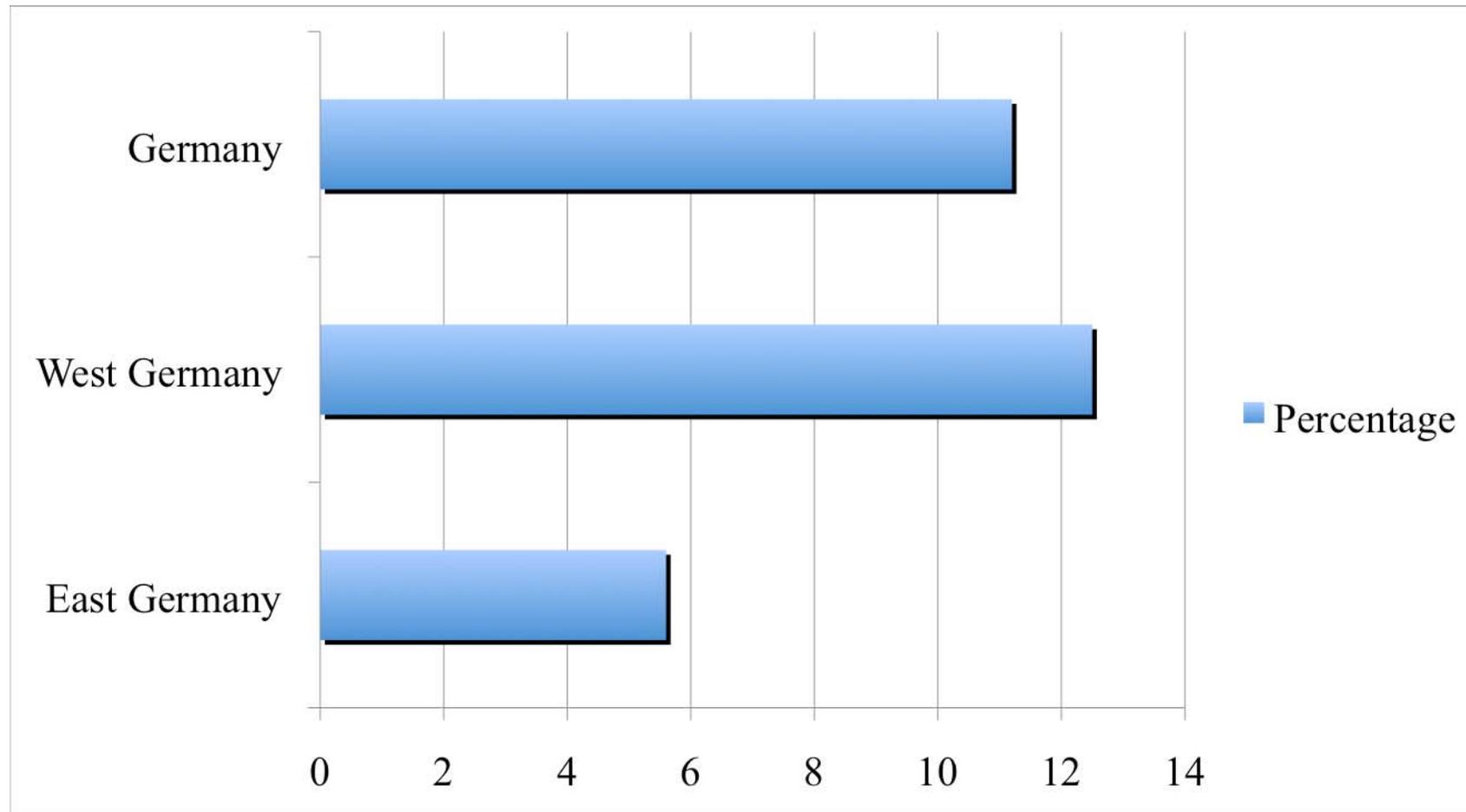
## Formation of Cluster



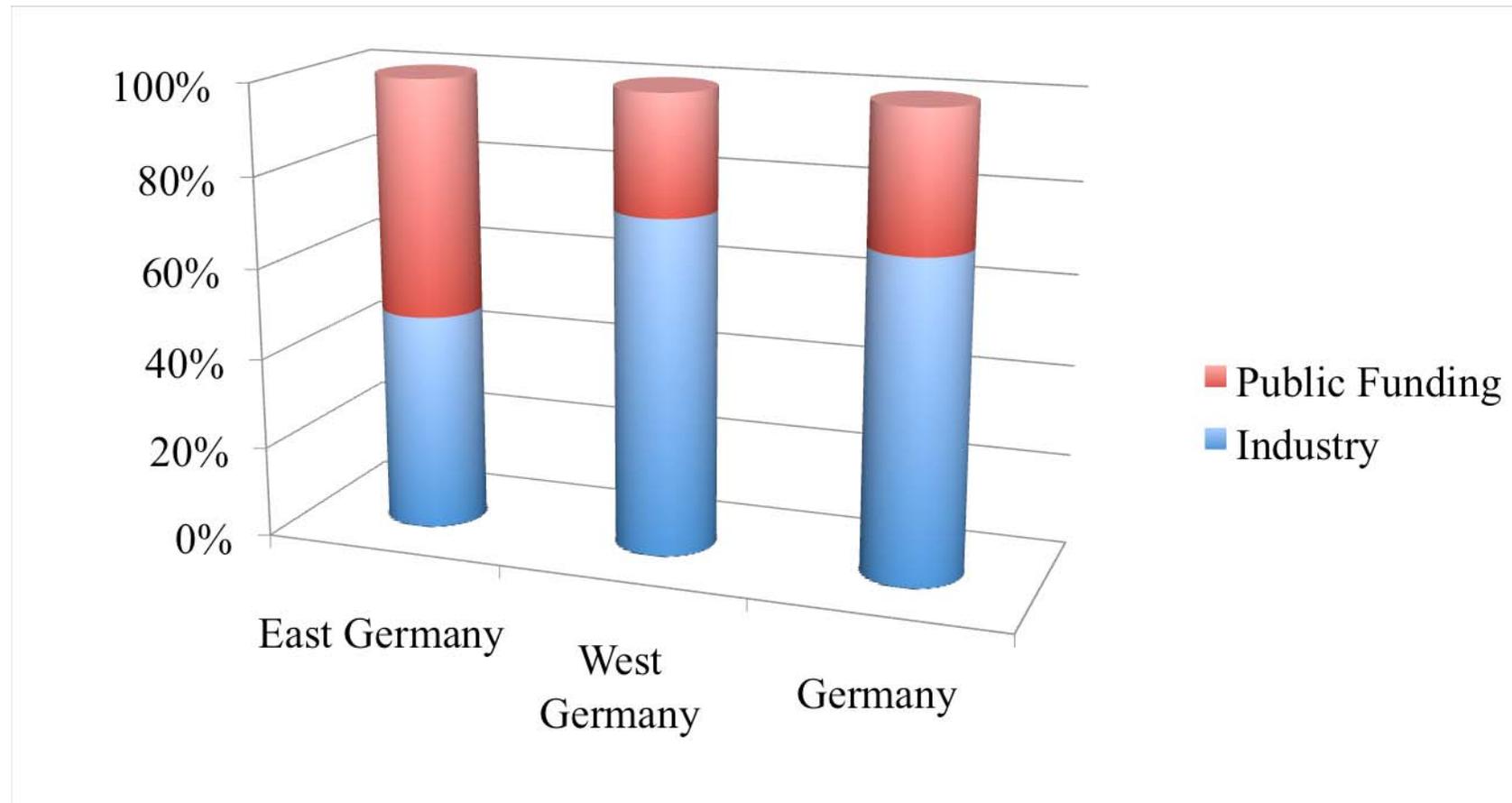
## Funding Programs in East Germany



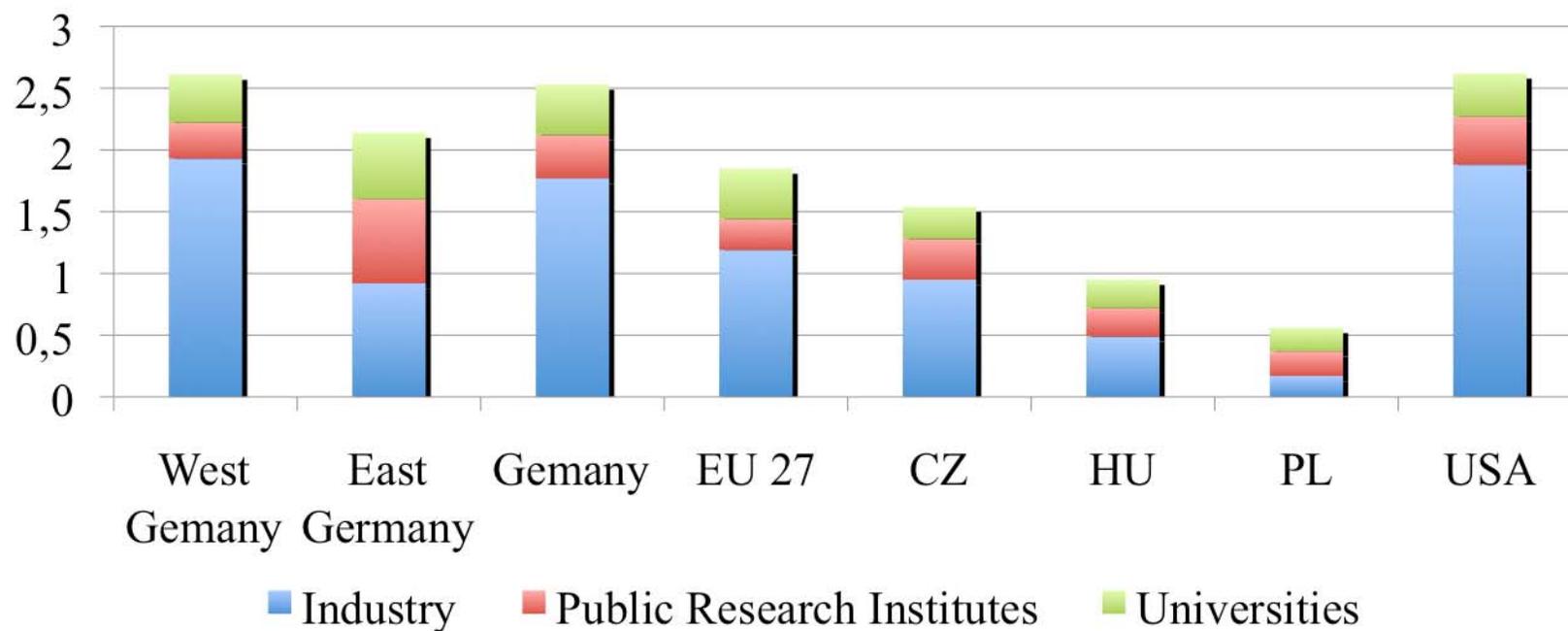
## Percentage of research intensive industry



## Percentage on R&D Funding



## Funding of R&D in % of the GDP



## **Cordus GmbH as an example for successful cooperation**

- Today corporate sectors and public research institutions are involved in common research.
- Regional innovation networks are based on the exchange of ideas between scientists from public research institutions and the managers and researchers in companies.
- The "face-to-face" contact between scientists from public research to the R&D personnel of companies is an important impetus for the R&D in the corporate sector and thus for the regional economic growth.
- Cordus GmbH a producer of reinforcement the automotive and engineering industry has built up a successful R&D network



## **Business Idea of Cordus**

- Cordus was founded 2007 and started the production end of 2008 with 30 employees.
- The foundation of Cordus was based on the idea to develop and to produce high-strength glass fibres and single-end glass cord with new hydrolysis and corrosion resistant surface properties for driving elements with improved adhesive systems with the help of nano- technology.
- The automotive industry demands that timing belts set the lifetime of an automobile. Timing belts, which have an appropriate release, are currently not available in the market.
- This project was presented to Volkswagen in 2007. Volkswagen showed great interest to find a supplier of glass cord in Europe, who could be also a strong partner for development.

## Technological Challenge

Glass cord as reinforcement in timing belts is exposed to tensile and compressive stresses. Additionally humidity has a negative effect on the strength of the glass cord. The hydrolysis of the silicon-oxygen bonding causes cracks in the glass fibre and reduces the tensile strength. The hydrolysis accelerates under tension (stress corrosion cracking).

The development of improved glass cord must therefore be carried out in three directions. Development of sizing and polymer coatings, that prevent or retard water permeation. A combination with inorganic fillers such as nano-tubes can slow down the permeation of water. In addition hydrolysis resistant glass fibres need to be developed as well as new technologies to coat the yarn surface with nano-particles.

## Technological Challenge

- The achieved level of adhesion of today used bonding agents is inadequate as well as the currently used coatings.
- Development of novel methods for the coating of the fibre material with nano-particles, in particular, a new layer forming CCVD
- Interfaces with a roughness of 10 to 30 nm to increase the surface energy of the fibre surface and generate active groups.

## Research Program InnoNet

„Development of a hydrolysis and corrosion resistant glass cord“ (support of the research institutes by Ministry of Commerce)

### Research institutes:

- Innovent, Jena
- Leibniz Institute for Polymer Research, Dresden

### Industrial partners:

- Volkswagen
- Albany International, USA
- Gates, EU
- JS Jodeit, Jena
- FIPA, Aachen

## Research Program IF

„Hydrolysis resistant glass fibres“, sizing technology, substitution of latex)  
(Support of Cordus by the State of Thuringia, 70%)

### Research institutes

- Innovent, Jena
  - CCVD procedure
  - Wet nano chemicals
- Otto Schott Institute, University of Jena
  - High tensile glass fibres
- Institute for Polymer Chemistry, University of Chemnitz
  - Adhesion additives in the nanometer area
- Institute of Engineering, University of Dresden (planned)
  - Development of dynamic measurement methods

## Research Programme IF

### Cordus GmbH

- Spinning procedures for high tensile glass
- Coating with nano particles during the spinning process
- Compression coating
- Twisting procedures

## Research Programme eE

Coating with Nano-Particles (CCVD), Adhesion to EPDM, (support of Cordus by the State of Thuringia, 40%)

Cordus GmbH

- Adaption of the CCVD procedure to the industrial production
- Development of adhesion additives to EPDM
- Surface Activation

## Industrial projects

- Volkswagen
  - Timing belts for engines
  - Timing belts for power steering
- Thyssen Krupp Presta
  - Timing belts for power steering
- Gates Mectrol
  - Glass cord in Polyurethane timing belts
- Teijin-Twaron
  - Aramide cord for turbo charger hoses

## Conclusion

- 20 years after unification business start-ups are now just as often as in West Germany. The proportion of entrepreneurs has become western standard.
- Medium sized enterprises become the backbone of the economy.
- The productivity has increased 4 times, and the per capita income had more than doubled.
- The gross domestic is over 70 percent of the West German level.
- In terms of profitability, the East German economy is ahead of the competition from the West. In the manufacturing industry the return in 2007 has an average of 5.1%; in West Germany it was 3.7%.
- Personnel costs per employee represent only 62.6% of the West German comparison value and the labour productivity 74.8%.
- For this reason the unit labour costs represent only 83.7% of the West German unit labour costs.

## Conclusion

- Positive studies about the effectiveness of the funding and incentive policy in East Germany.
- The manufacturing industry contributes 19.3 percent of the gross value - more than in industrialized countries like Britain, France or the United States.
- The rebuilding of the innovation system after a complete failure of the economic system, combined with a strong de-industrialization and massive loss of industrial research required more than 20 years.
- East Germany experienced high incentives for R&D- and innovation projects by the government to address the structural handicaps. Innovative programs such as "Regional Enterprises " or "Network Management East" primarily aimed at cooperation between companies and with academic institutions to compensate the disadvantages caused by the small size of the companies.

## Conclusion

- The development in East Germany has shown, that new foundations of foreign investors do not have to be necessarily effective for the innovation.
- Regarding the technological capabilities of the East German manufacturing sector, it seems appropriate to give to the endogenous development of small and medium-sized (local) businesses more attention.

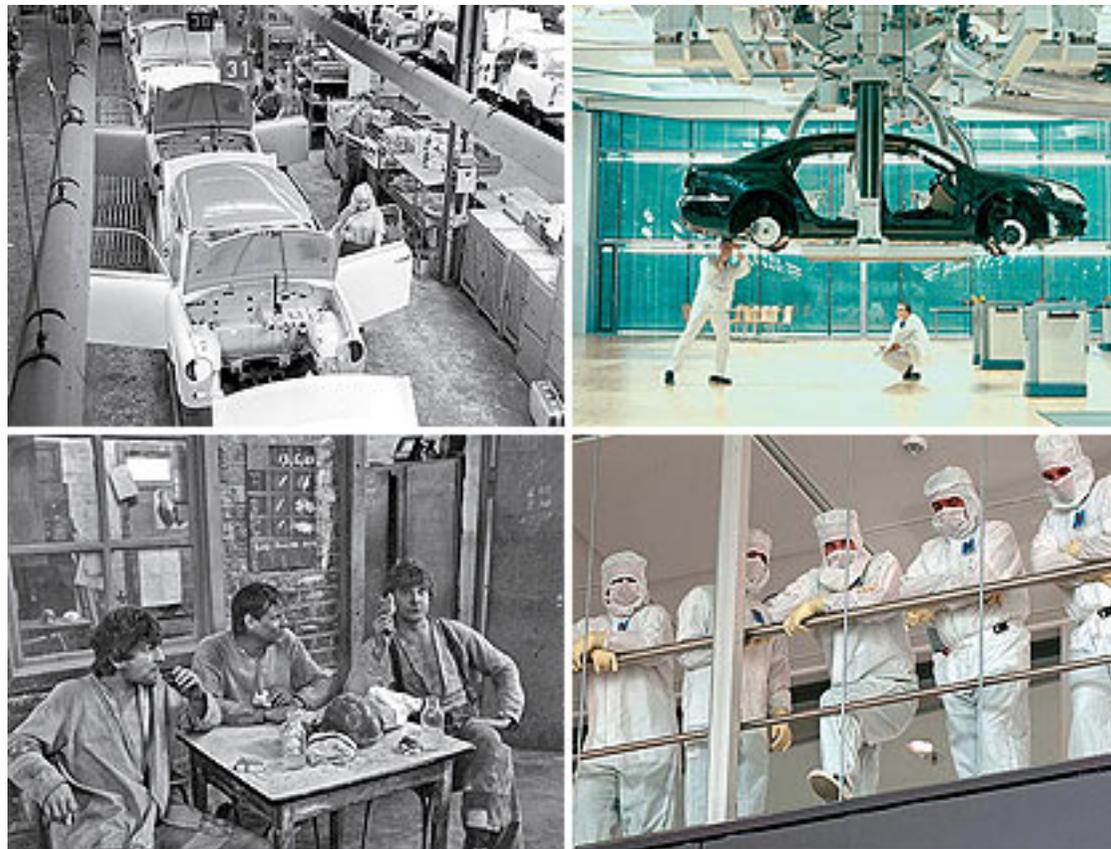
## Outlook

The growth potential of a region was connected in the past to its hard location factors.

The focus is again more on the quality of human capital, on specific business skills and the presence of scientific institutions in the region.

Three elements are important

- a) Innovative actors (inventors, companies, research institutions)
- b) Their common focus on a specific technology and
- c) The existence of a cluster of innovative actors.



**Thank You for Your Attention**