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Work Package 4
"Structural Change and Globalisation"

CASE STUDY

NORTH RHINE-WESTPHALIA (DE)

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Acronyms

BERD	Business Expenditure on R&D
DPMA	German Patent and Trade Mark Office
ERDF	European Regional Development Fund
ESF	European Social Fund
EU	European Union
GERD	Gross Domestic Expenditure on R&D
GDP	Gross Domestic Product
GRP	Gross Regional Product
GVA	Gross Value Added
ICT	Information and Communication Technology
IWR	Institute of the Renewable Energy Industry
LDS	State Office for Statistics and Data Processing
NGO	Non-governmental Organisation
NPO	Non-profit Organisation
NRW	North Rhine-Westphalia
NUTS	Nomenclature of Territorial Units for Statistics
PPS	Purchasing Power Standard
REN	Rational Energy Use and Exploitation of Renewable Resources
R&D	Research and Development
RTDI	Research, Technological Development and Innovation
SME	Small and Medium Enterprise
SPD	Single Programming Document
ZEW	Centre for European Economic Research

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Executive summary

Scope and research methods

This report has been prepared in the framework of the ex post evaluation of cohesion policy programmes 2000-2006 co-financed by the European Regional Development Fund (Objectives 1 and 2). It is part of the Work Package 4: Structural Change and Globalisation.

This case study focuses on analysing the results and outcomes of a set of specific measures of the ERDF 2000-2006 Objective 2 programme implemented in the North Rhine-Westphalia region and considered particularly relevant in the context of structural change and adaptation to globalisation: Measure 2.8 is dealing with the development of a cluster in the energy sector, while Measure 3.3 is supporting the development of regional technology and training infrastructures.

The study is based on various information sources: an in-depth analysis of available documents (programming documents, programme complement, annual implementation reports, mid-term and final evaluations, regional studies); monitoring data of the programme; phone interviews with regional authorities, representatives of the state bodies in the region, and with final beneficiaries of the specific measures under review, including companies; as well as data from the regional statistical office (LDS) and Eurostat.

Key research question and hypothesis tested in the case study

The main research question addressed by this case study is the extent to which regional policy measures, co-financed by the ERDF (European Regional Development Fund), supporting structural change and adaptation to globalisation[1] have helped to foster sectoral competitiveness and to increase the innovation potential of regional enterprises in the eligible areas of North Rhine-Westphalia (Germany). In particular, did the ERDF support lead to improved industry science links in the eligible areas allowing them to exploit better the strong regional supply of scientific and technological knowledge? Given the emphasis of the programming document, the case study focuses on two specific types of measures that have been supported: cluster development in the energy sector and the complementary development of the regional technology and training infrastructure.

The assessment of the effects of the selected ERDF measures aims to highlight the contribution of the Objective 2 programme to structural change in the region, and in doing so tests two of the working hypotheses proposed in the conceptual model developed by the study. Firstly regional specialisation is addressed: *Problems of structural change and vulnerability to globalisation are frequently a consequence of lock-in effects and negative selection mechanisms that slow down the necessary change and restructuring.*

Secondly innovation capacity is under scrutiny: *apart from significant differences among Objective 2 regions in terms of institutional thickness, their innovation systems may suffer from missing innovation drivers on the demand*

[1] By measures "supporting structural change and enabling adaptation to globalisation", the study refers to public intervention to promote the reallocation of resources (labour and capital) towards more efficient ends, either directly (e.g., promoting start ups, or favouring SMEs' technological intake) and/or indirectly, by minimising possible adverse effects of structural change.

side. Barriers to innovation are determined by a lack of absorptive capacity by local firms. Especially in old-industrial areas, path-dependence from existing technological trajectories constrains product and process innovation.

Regional context and key findings

North Rhine-Westphalia's Objective 2 region can be regarded as a blueprint of an old industrial area that has been subject to various research efforts with a history in structural change going back more than 30 years. While the coal and steel industry already approached the end of their life cycles during the first half of the 20th century, the structural problem remained hidden behind short-term changes in demand, and for a long period the regional ruling elite failed to acknowledge the need for dramatic re-orientation of the Ruhr economy. Active structural change by means of diversification in the industrial structure was only pursued relatively late (the 1970s).

Being mainly dominated by its coal, iron and steel production industry in the past, the region was facing in the beginning of 2000 in particular two challenges. Having gone through tremendous changes in its economic structure since the 1970s the question of regional specialization needed to be addressed. As other economic sectors were in the past incapable to compensate for the loss of employment in the coal, iron and steel production industry new approaches for the renewal of the regional firm base were necessary. Second the further development of the regional innovation potential was paramount, since diversification and consolidation of the regional industry base did not stop the erosion of old competences.

Policy tried in the period 2000 to 2006 to bring forth adequate responses to these challenges:, 'Future technologies in the energy sector', and 'technology and training infrastructure' can be seen as addressing the problems of this old industrial area. In particular the last two measures where addressing explicitly or implicitly the development of new high technology clusters. Both measures have been accordingly selected (in adjustment with regional experts) for further assessment.

The key findings of this case study are the following:

The integrated planning approach of the ERDF programming period 2000 to 2006 proved essential for addressing the existing challenges of structural change

Poor innovation performance in the enterprise sector, the lack of regional industry science links in combination with a persistent industry based sectoral structure created an increased vulnerability of the region to exogenous market and technological shocks. Regional programming responded to these multidimensional challenges with a planning approach that was addressing promising regional technology fields. The concept of competence field (i.e. cluster) development was thus bundling different types of interventions under the umbrella of specific themes (i.e. energy, logistics, medical technology). In doing so, necessary actions (i.e. networking, infrastructure development) for the development of clusters could be funded accordingly.

The new concept of integrated planning brought forth an innovative approach towards projects

The structural funds planning period 2000 to 2006 opened up new ways for the design of public interventions. Integrated projects - comprising several dimensions of regional policy such as infrastructure

development, training, and R&D funding - were successfully introduced by the regional government. These integrated projects also proved to be an adequate response to the multidimensional challenges of regional structural change in North Rhine-Westphalia. As the case of the "Zentrum für Brennstoffzellentechnologie" shows, funding under individual measures in Priority Axis 2 "innovation and competence development" were in combination on the one hand resulting in an expansion of the regional R&D infrastructure and technological knowledge base, on the other hand industry-science links were successfully initiated.

Technology infrastructure development was also supportive to the integrative cluster approach

The funding of technology infrastructure projects was successfully coordinated by the setting of thematic priorities. New centres and incubators were thoroughly aligned with the prioritised technology fields in North Rhine-Westphalia. Thus emerging clusters could be supported by the means of new technology infrastructure. In particular new infrastructures were developed in the field of medical technology: This is a cluster (lead market health) that will be further developed in the programming period 2007 to 2013. New infrastructures had also positive effects on the creating of regional industry-science co-operations, addressing thus one of the key challenges of structural change.

Main message

The analysis demonstrates how the interactions of two dimensions of structural change have led to persistent disadvantageous sectoral patterns and a poor innovation performance in the region. The cluster (or competence field) development approach of the overall programming strategy proved to be an adequate response to the complex challenges of structural change in the Ruhr area as described in the case study. It functioned thereby as a coordinating thematic umbrella of several measures trying to bring fourth synergies with an integrated policy mix. With the interventions in several measures the groundwork has been laid implicitly and explicitly for future clusters.

Although cluster development stranded the test as a new approach, development of new high technology sectors in the Ruhr area will need a lot of time. As the anecdotal evidence and qualitative results demonstrates, new emerging technologies like hydrogen and fuel cell technologies are in their initial stages of the technology life cycle; prototypes may require many more years before successful commercialisation becomes possible. A timeframe of only four to six years will never be enough "to change the world". Thus, new prospective technology (i.e. cluster based) strategies should not be judged by their success in terms of economic growth or employment generated, but rather by their ability to bring forth sustainable structures and institutionalised networks.

Introduction

North Rhine-Westphalia's Objective 2 region can be regarded as a blueprint for an old industrial area that has been subject to various research efforts (Bautzen 1993, Cooke et al. 1995, Heinz et al. 1998, Schrader 1998). In the beginning of the programming period 2000 to 2006 the region already had a history of structural change going back more than 30 years. Being mainly dominated by its coal, iron and steel production in the past, by 2000 the region was facing two challenges. First, having gone through tremendous changes in its economic structure since the 1970s the question of regional specialization needed to be addressed. As other economic sectors were in the past incapable of compensating for the loss of employment in the coal, iron and steel production new approaches for the renewal of the regional firm base were necessary. Second, the further development of the regional innovation potential was paramount, since diversification and consolidation of the regional industrial base would not be sufficient on their own to stop the erosion of old competences.

The following case study will show in North Rhine-Westphalia in the period 2000 to 2006 how regional policy and in particular ERDF programming responded to these challenges, and also how quantitative and qualitative evidence on the effects of policy interventions was collected and assessed. The case study is divided into four sections:

- **Section 1** first provides a brief introduction of the region in focussing on basic indicators such as regional income, population and employment. Second, the roots of structural change are explored and - going back to the 19th century - the causes of the region's initial success and later downturn are discussed. Third, a discussion of the relevant dimensions of regional structural change for the period of 2000 to 2006 is presented, based on statistical indicators for regional economic structure and for R&D and innovation performance. Based on the two main challenges described above three working hypotheses are formulated. These address the lack of firm formations, industry-science co-operations, and the need for an integrated cluster development approach as a new adequate answer to structural change. This naturally leads to discussion of specific dimensions of structural change such as the issues of regional specialisation, regional innovation potential, and the geography of structural change are discussed.
- **Section 2** then sheds light on regional policy and its strategies, objectives and instruments for the programming period 2000 to 2006. After brief discussions of the relevant regional policy mix and the overall strategic outline of the programme, the related measures for the dimensions of structural change are presented. First, the overarching competence field (i.e. cluster) development approach of the programme strategy is discussed in relation to the relevant measures. Next, three measures are selected for further analysis. The measures have been selected in the light of the working hypotheses established in section 2, i.e. according to their potential to contribute to the renewal of the regional firm, their effect on the development of new emerging technology based clusters, and their contribution to the fostering of industry science co-operations. Finally the selected measures are discussed in terms of the background context comprising information on the respective intervention logic, the concrete instruments applied, and the beneficiaries addressed.
- **Section 3** provides a detailed discussion of each selected measure. First, the measures are discussed on the basis of available monitoring data. Insights into performance and leverage effects (in terms of total

and private investments induced) are provided. Also, a discussion of output indicators collected in the course of programme monitoring is included; findings of the mid-term evaluation are integrated where possible. Second, the measures are discussed and assessed on the basis of the complementary field work. Third, effects on institutional capacity building and policy learning are discussed on a qualitative level. The qualitative discussion of the effects of the measures is as far as possible complemented by regionalised data in order to provide comparable quantitative evidence. In particular, the following data sources have been used:

- Regionalised data on new entries in the business register have been provided by the Landesamt für Datenverarbeitung und Statistik (LDS) and its database (i.e. Landesdatenbank).
- Regionalised data on firm formation rates from the Centre for European Economic Research (ZEW).
- Data on the structure and development of the renewable energy sector were provided by the Institute of the renewable energy industry (IWR).
- Data on firms in the newly established technology infrastructures were obtained by the centres themselves.
- Complementary qualitative information has been collected from 10 interviews with beneficiaries and 2 interviews with regional experts and policy makers.

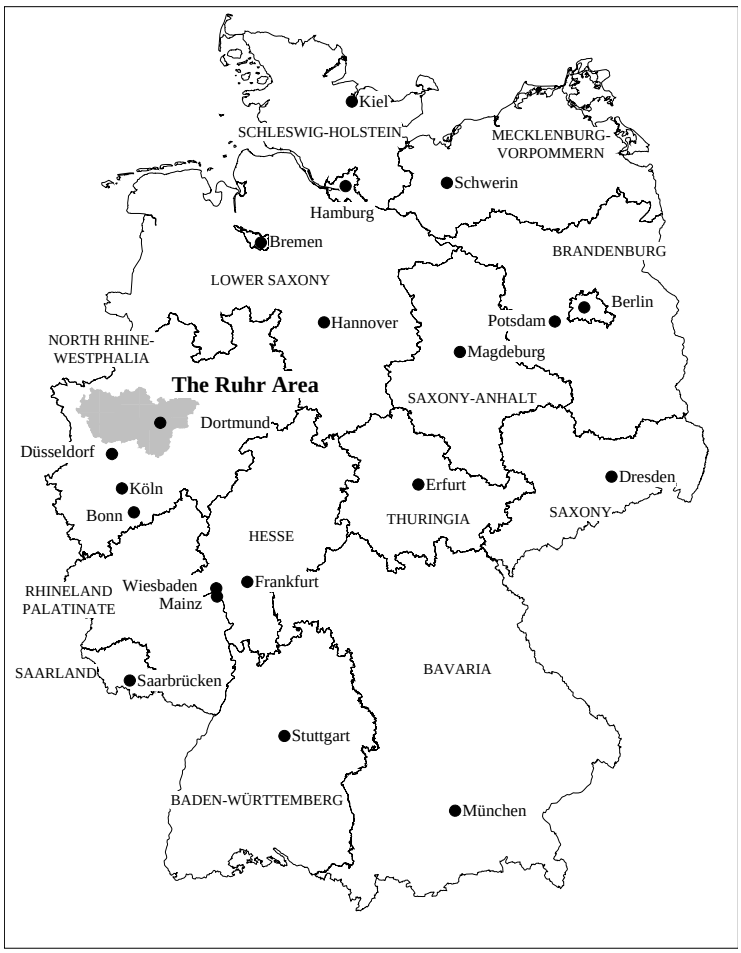
- **Section 4** then draws conclusions from the findings collected addressing both the dimension of each measure and of the whole programme.

1. Structural change and globalisation in perspective

1.1 The region at glance

North Rhine-Westphalia is the fourth largest of the 16 German Bundesländer (NUTS 1 Level regions), covering an area of 34,080 km². The population (as of 2006) was 18,043,000 inhabitants corresponding to about 21.9 % of the total population of Germany. In terms of population, North Rhine-Westphalia thus ranks thereby first among all German NUTS 1 regions. In 2000, Gross Value Added (GVA) at basic prices amounted to € 408,814 million, 22 % of the national value.

Figure 1.1 - Location of North Rhine-Westphalia and the Ruhr area

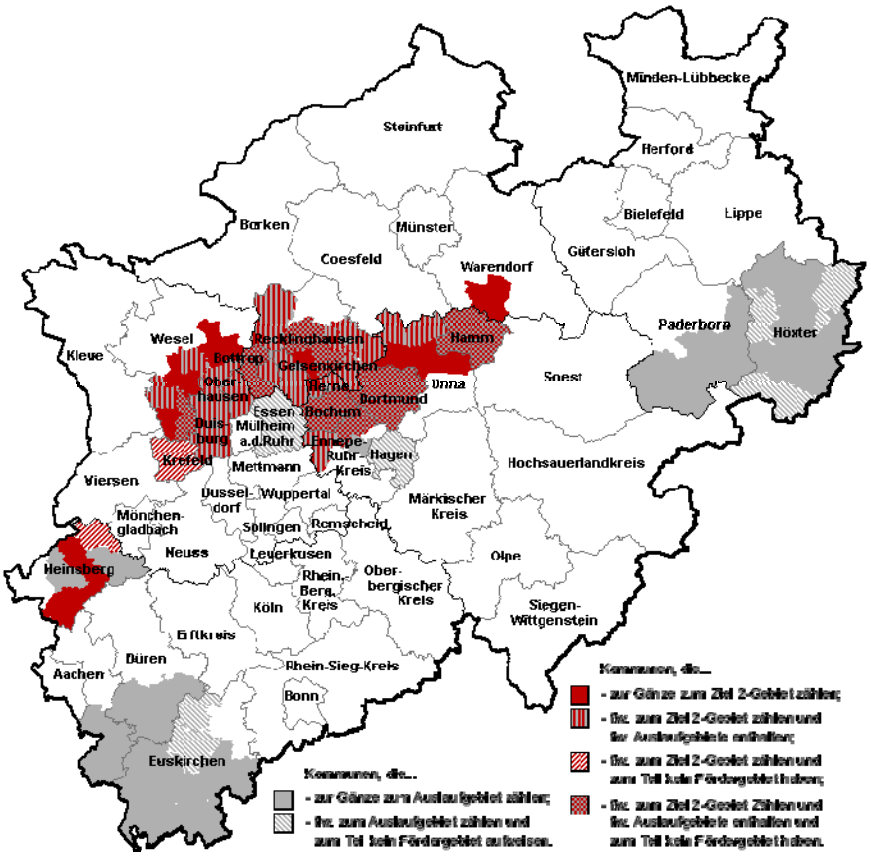


Source: Bros/Walter (2000).

The development of the regional GVA for the programming period 2000-2006 at +11.6 % was slightly below the national figure (+ 12.8 %) and significantly below reference values for the EU15 (+ 24.4 %). Regional income (GDP per capita in €PPS) reveals related patterns: in 2000 €PPP 25,200 puts the region slightly above national figures (€PPS 25,100) and above the European average (€PPS 23,117). A comparison with the industry locations of Bayern (€PPS 29,500) however reveal a gap. Average growth rates for 2000-2006 show a

weaker performance (+ 11.1 %) compared to Germany at the national level (+ 12.4 %) and the EU15 (+ 15.5 %).

Figure 1.2 - Objective 2 Region in North Rhine-Westphalia 2000-2006



Source: Ministerium für Wirtschaft und Mittelstand, Energie und Verkehr des Landes Nordrhein-Westfalen (2001).

The Objective 2 region in North Rhine-Westphalia covers an area of 6,053 km² with about 5.1 million inhabitants and can be regarded as one of the largest, old industrial areas in Europe and has been – with only minor changes in geographical scope – receiving ERDF funding for structural change since 1989. The Objective 2 area for the programming period 2000-2006 is focused on major parts of the Ruhr area and in plus the coal mining region in the Heinsberg district. The following districts (Landkreise) are covered: Bochum, Bottrop, Dortmund, and Duisburg. The Objective 2 area is characterised by high population density in an already densely populated NUTS 1 region: on average population density in the Objective 2 region is 856 inhabitants per km² which is 1.6 times above the average value for whole North Rhine-Westphalia.

Population development in North Rhine-Westphalia stagnated between 1995 and 2000 (+ 0.8 %), and for the programming period i.e. the years 2000 to 2006, this trend continued (+ 0.2 %). The national reference value for the years 2000 to 2006 (+ 0.23 %) shows a similar trend. In addition the age structure of the population is shifting, leading in the long-term to an ageing of the regional working population. Against this background of a stagnating population and shifting age structure, North Rhine-Westphalia's total employment rate has changed only marginally from 2000 (50.4 %) to 2006 (50.9 %). Again, this trend is also reflected on the national level (change of the employment rate 2000-2006: + 0.6 %). However, the reference values for the

EU15 reveal a different picture: in 2001 the employment rate was 44.3 %, in 2006 this increased to 53.4 % (+ 20.3 %).
In contrast to the modest development in terms of the employment rate, North Rhine-Westphalia has shown for the time-span 2000 to 2006 slightly more favourable unemployment rates than the national average. The unemployment rate in North Rhine-Westphalia amounted to 6.5 % (Germany 7.9 %) in 2000 and increased to 9.8 % (Germany 10.2 %) in 2006. Nevertheless, it has to be noted that once rates of change are considered, the picture is rather different: while the unemployment rate has risen in North Rhine-Westphalia from 2000 to 2006 the reference value for Germany was only 29.1 percentage points.
Although having gone through a long period of restructuring, North Rhine-Westphalia's economic structure is still influenced by its industrial past. In 2000 the share in the industry sector still was 33.9 % of total regional employment (EU15 28.9 %), although it is noteworthy that the national German reference value for 2000 (33.5 %) is almost identical. The values for 2006 provide a similar pattern: while industry's share of total employment in North Rhine-Westphalia was 29.3 %, the German average value amounted to 29.6 % (EU15 26.6 %). Nevertheless it should be noted that change is occurring faster in North Rhine-Westphalia (-13.4 %) than in Germany (-11.7 %) or in the EU15 (-9.1 % on average).

1.2 Searching for the roots of change: socio-economic history of the region

1.2.1 The Ruhr area as a prototype of an old industrial area

The economic history of the Ruhr area can be seen as a blueprint for a region whose initial success led to subsequent downturn. The success story of the Ruhr area started during the industrialisation phase in the 19th century. It was based on five major factors that were present in the region (Schrader 1998, p. 437): i) technological innovations, which mostly were imported from Great Britain, ii) improved transport infrastructure, namely extended railway network and canals, iii) import of capital, iv) political and economic liberalisation, and v) dynamic entrepreneurship.
The growth of the Ruhr economy relied to a large extent on technological innovations which made large scale coal mining and steel production possible. In the course of the industrialisation until the start of the twentieth century, more and more industries became integrated within the coal and steel industrial complex ("Montankomplex"): e.g. power generation and chemicals (e.g. Heinze et al. 1998, p. 267). The formation of the coal and steel complex was mainly resource-based. Large scale coal mining was a location factor supporting steel production and made relatively cheap production of energy possible. Furthermore, at that time, many chemical processes relied on coal. This process of vertical integration was, in addition to the dependence on regional natural resources, one of the main factors for the later crisis and the difficulties that had to be faced in the context of structural change (Bros/Walter 2000). The phases of economic growth and decline of the Ruhr economy are summarised in Table 1.1:

Table 1.1 - Overview of the economic history of the Ruhr area

Time period	Phase	Characteristics
before 1840	Pre-industrialisation	· Small coal mines, iron and textile factories · Agricultural areas with low population density
from 1840	Industrialisation with strongest growth phase between 1894 – 1914	· Large-scale coal mining and development of coal chemistry · Introduction of mass production of iron and steel · Foundation of large enterprises · Strong immigration
1914 – 1945	First signs of crisis	· Economic depression, world wars I and II, dismantling of product lines after WW II · End of product cycle of coal mining
1945 – end of 1950s	Rapid growth	· temporary demand pull due to reconstruction and Korean war caused over-capacities
1960s – today	Restructuring and transition	· Crisis of coal mining and closure of pits: international competition and location disadvantages due to changed technology · Absorption of workers in other sectors (1960s) · Steel crisis in 1974 with overall decline of the region

Source: Bross/Walter (2000).

The first signs of decline in the Ruhr economy were observable as early as between the First and Second World Wars. However, the reconstruction beginning after the Second World War from the late 1940s onward, only postponed the crisis (Bros/Walter 2000). External factors such as the Korean War in the beginning of the 1950s accounted for additional (artificial) demand pull effects. Schlieper (1986) for instance argues that the industry on which the Ruhr area relied had already reached the end of its product life cycle in the 1940s (1986, p. 145).

While the most visible external events affecting the coal and steel complex are the coal crisis in 1957 and the steel crisis in 1974, the decline of the region has to be understood as the salt of a process going back to the early days of industrialisation (Dege/Kerkemeyer 1993). Starting in 1957, several political measures, at regional level, national and European level, were undertaken in order to promote restructuring. One main goal has always been to minimise social disparities. However, the process takes decades, and even by the 1990s the Ruhr area had still not entirely overcome its structural crisis. While the first signs of recovery were visible during the 1980s, the world recession in 1992/93 had very strong negative impacts on the Ruhr economy.

1.2.1 Phases of structural change

While the coal and steel industry already approached the end of their life cycles during the first half of the 20th century, the structural problem remained hidden behind short-term changes in demand, and for a long period the regional ruling elite failed to acknowledge the need for dramatic re-orientation of the Ruhr economy (Bros/Walter 2000). Active structural change by means of diversification in the industrial structure was only pursued relatively late (the 1970s).

Table 1.2 - Phases of structural change in the Ruhr area

Time span	Overall development and indicators	Milestones	Policy approach
until 1970s	Perpetuation: Employment decrease in coal and steel industry Relative low unemployment	1957 and 1974 coal and steel crisis Opel investment in Bochum	· subsidies · Supply-side policies · Centralised policy
end 1970s – 1989	Diversification New branches Growth of service sector	Economic crisis of Hoesch Closure of steel plants in Rheinhausen und Hattingen	· Regionalisation · Decentralisation · SMEs · Diversification · Attract extra-regional investment
1990 – mid 1990s	Consolidation & crisis Productivity growth in traditional sectors	Mergers World economic crisis 1992/93	· Umbrella projects · Bundling resources · Initiating networks
Mid 1990s - today	Cluster approach Diversified industrial structure		· Stimulating firm formation · (see above)

Source: Bros/Walter (2000), adaptation JR-InTeReg

The phases of the process of structural change until the beginning of the programming period 2000-2006 can be characterised as follows (see also Table 1.2):

- Until the 1970s central planning initiatives on the federal state level and national level prevailed, thus perpetuating the existence of the traditional industries in the region. Initial (hesitant) attempts to attract extra-regional capital were made. Supply-side oriented policy fostered the building of universities in the Ruhr area.
- The period from the late 1970s until 1989 was marked by the harsh consequences of the steel crisis in 1974. In 1981, the Hoesch group almost went bankrupt, causing heavy cuts in employment (from 24,000 in 1957 to 13,000 in 1987), in 1986/87 the closure of steel plants in Hattingen and Rheinhausen threatened social stability in the region. At the same time, large enterprises started to diversify, but mostly outside the region. New industrial and technology policy implied a change of planning focus towards regionalisation. Active structural change in contrast to passive accommodation of declining industries was promoted, e.g. strengthening the role of SMEs and technology transfer in the diversification of industry. During this period, initial signs of economic recovery could be seen mostly due to the growth in the service sector.
- From 1990 until the mid 1990s, the Ruhr area experienced first a boom and then a crisis after German unification. The steel industry went through a phase of consolidation with strong rationalisation and takeovers or mergers between the major players (i.e. takeover of Hoesch by Krupp 1993; merger between Krupp and Thyssen in 1997). The economic crisis in 1992/93 hit the North Rhine-Westphalian economy especially hard, since the steel and manufacturing sectors are relatively strongly export-oriented: almost half a million jobs were lost (Land Nordrhein-Westfalen 1996, p. 33). In the 1990s, the federal state government pursued an active modernisation policy.

1.3 Regional structural change and globalisation issues in 2000-2006

1.3.1 Dimensions of structural change

The socio-economic history of North Rhine-Westphalia and the Ruhr area the sequence of phases of structural change experienced over the past 30 years shapes the issues to be addressed for the programming period 2000-2006. The storyline of section 1.2 is thereby leading to two concrete issues: first, regional specialization needed to be dealt with since the tremendous changes in the economic structure that North Rhine-Westphalia suffered in the past demanded strong policy actions. Second, regional innovation potential has to addressed, since lock-in effects in regional specialisation very often lead to poor regional innovation performance caused by low absorptive capacities for R&D results.

1.3.1.2 Regional specialisation

As the conceptual model of the first intermediate report has shown, some Objective 2 areas specialise in industries that suffer from severe external competition. The spatial concentration of economic activities and possible externalities of agglomeration have to be taken into account in this regard. Problems of structural change and vulnerability to globalisation are frequently a consequence of lock-in effects and negative selection mechanisms that slow down the necessary change and restructuring. In this section evidence will be presented to show that North Rhine-Westphalia's Objective 2 region is facing problems stemming from regional specialisation.

A comparative examination of the structure of regional employment by macroeconomic sector for the years 2000 and 2006 shows (see Table 1.3) that North Rhine-Westphalia (29.3 %) was still more industrialised than the EU15 average (26.6 %).

Table 1.3 - Employment by sector on NUTS 1 level in comparison to Germany and EU15, 2000 and 2006

Employment by sector										
		Regional			National			EU15		
Indicator	Unit	2000	2006	Δ(%) 00/06	2000	2006	Δ(%) 00/06	2000	2006	Δ(%) 00/06
Agriculture	% on total employment	1.7	1.5	-12.1	2.6	2.3	-14.3	4.3	3.6	-16.1
Industry	% on total employment	33.9	29.3	-13.4	33.5	29.6	-11.7	28.9	26.6	-9.1
Services	% on total employment	64.3	69.1	7.4	63.8	68.2	6.8	66.4	69.6	4.8

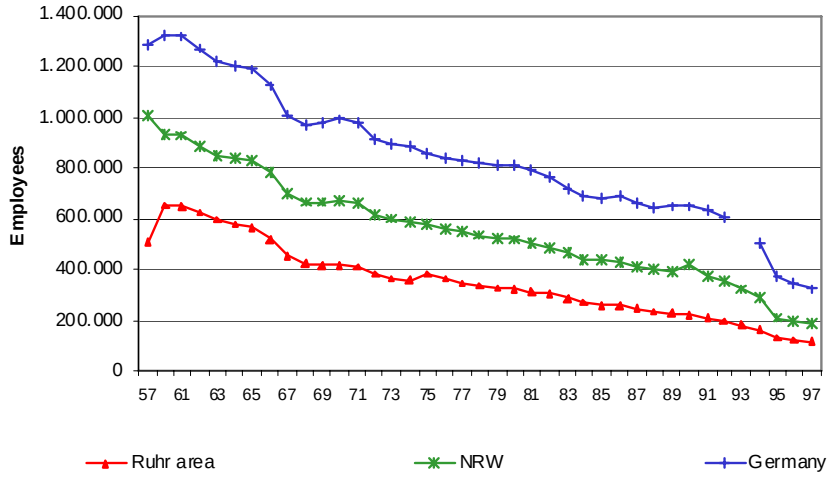
Source: Core team processing of Eurostat data

It is noteworthy that Germany as a whole showed a lower rate of change (i.e. 11.7 %) than North Rhine-Westphalia, an old industrial region (i.e. 13.4 %).

The Objective 2 area in North Rhine-Westphalia was traditionally dominated by the coal, iron and steel industry. The dependence of the region on large scale vertically integrated firms in the coal and steel sector led to a significant decrease in jobs in the past, as other sectors were not able to compensate for the loss. The structural problems of the Ruhr area at the beginning of the programming period 2000-2006 can thus be

traced back to this unfavourable economic heritage. Figure 1.3 provides an overview of the decrease in employment in the last four decades before the programming period:

Figure 1.3 - Employment in the coal, iron and steel production sector for Germany North Rhine-Westphalia and the Ruhr area (1957-1998).



Source: KVR (1999)

From 1980 to 1998 more than 165,000 jobs were lost in the coal and steel industry, 78,000 jobs and 87,000 jobs respectively. Since 1980, six out of ten jobs have been lost in the coal, iron and steel sector in the Objective 2 region Clearly, structural change in this sector accounts to a very large extent for the overall decrease in employment in the region (with a particular focus on the Ruhr area).

Table 1.4 - Employment structure in selected branches of the industry sector in the Objective 2 region. 2003-2006

NACE	Sectors	2003	2004	2005	2006
		Share in %			
CA	Extr. of oil and natural gas	5.2%	5.1%	4.5%	2.2%
CB	Extr. of gravel and clay etc.	0.3%	0.3%	0.3%	0.0%
DA	Mfr. of food, beverages and tobacco	6.5%	6.7%	6.7%	7.0%
DB	Mfr. of textiles and leather	1.6%	1.5%	1.6%	1.6%
DD	Mfr. of wood and wood products	0.4%	0.3%	0.3%	0.5%
DE	Mfr. of paper prod.; printing and publish.	3.5%	3.5%	3.4%	3.4%
DG	Mfr. of chemicals	9.7%	9.1%	9.1%	9.3%
DH	Mfr. of rubber and plastic products	2.5%	2.6%	2.7%	2.8%
DI	Mfr. of other non-metallic mineral products	3.0%	3.1%	3.2%	3.2%
DJ	Mfr. and processing of basic metals	23.4%	24.3%	24.7%	24.7%
DK	Mfr. of machinery and equipment	16.2%	16.5%	16.6%	17.4%
DL	Mfr. of electronic equipment	8.5%	8.9%	8.8%	8.6%
DM	Mfr. of transport equipment	2.7%	2.9%	2.9%	2.9%
DN	Mfr. of furniture; manufacturing n.e.c.	2.4%	2.2%	2.4%	2.3%

Source: LDS Düsseldorf, own computations

Table 1.4 provides an overview of industry employment structure in the Objective 2 region by sectors. As can be seen, for the second half of the programming period 2000-2006, manufacturing and processing of basic metals remained a dominant sector, while mining and quarrying further lost relevance in terms of structural share. Machinery and equipment remained important, expanding its relative share from 2003 (16.2 %) to 2006 (17.4 %). Other sectors of relative importance in the Objective 2 region have been manufacturing of electronic equipment (2006: 8.6 %) and manufacturing of chemicals (2006: 9.3 %). Thus it may be concluded that the Ruhr area was in the period from 2000 to 2006 still highly specialised in coal, iron and steel production, despite big losses in respective sectoral employment in the past.

When absolute numbers of employees and change rates from 2003 to 2006 are considered[2], it becomes obvious that neither manufacturing in total, nor any specific industry sector, was able to generate enough growth to foster the necessary restructuring effort (see Table 1.5).

Table 1.5 - Employment in the objective 2 region in the manufacturing sector, 2003-2006

NACE	Sector	2003	2004	2005	2006		
		Employees				Change in % 2003-2006	Change in total numbers 2003-2006
CA	Extr. of oil and natural gas	17,253	16,207	13,897	6,520	-62	-10,733
CB	Extr. of gravel and clay etc.	1,073	1,054	896	112	-90	-961
DA	Mfr. of food, beverages and tobacco	21,500	21,166	20,875	21,278	-1	-222
DB	Mfr. of textiles and leather	5,178	4,907	4,824	4,733	-9	-445
DD	Mfr. of wood and wood products	1,330	1,074	952	1,464	10	134
DE	Mfr. of paper prod.; printing and publish.	11,599	11,016	10,451	10,221	-12	-1,378
DG	Mfr. of chemicals	31,888	28,951	28,141	28,136	-12	-3,752
DH	Mfr. of rubber and plastic products	8,349	8,360	8,365	8,563	3	214
DI	Mfr. of other non-metallic mineral products	9,999	9,936	9,939	9,704	-3	-295
DJ	Mfr. and processing of basic metals	77,291	77,198	76,376	74,576	-4	-2,715
DK	Mfr. of machinery and equipment	53,634	52,533	51,352	52,634	-2	-1,000
DL	Mfr. of electronic equipment	28,197	28,127	27,307	25,889	-8	-2,308
DM	Mfr. of transport equipment	8,987	9,228	8,868	8,759	-3	-228
DN	Mfr. of furniture; manufacturing n.e.c.	7,838	6,851	7,386	6,965	-11	-873

Source: Landesdatenbank, own computations

The highest burden of jobs losses was borne by mining and quarrying (i.e. coal mining) with a total loss of -10,733 jobs from 2003 to 2006. Other branches with particularly big decreases in employment between 2003 and 2006 were manufacturing of chemicals (-3,725), manufacturing and processing of basic metals (-2,715), and manufacturing of electronics (-2,308).

Thus we may summarize that in order to overcome the prevailing sectoral specialisation patterns, new strategic approaches moving beyond past diversification activities have to be addressed by regional policy.

[2] Due to the changes with the NACE revision 2002 only the time-span from 2003 to 2006 can be observed with comparable data on regional level (NUTS 3).

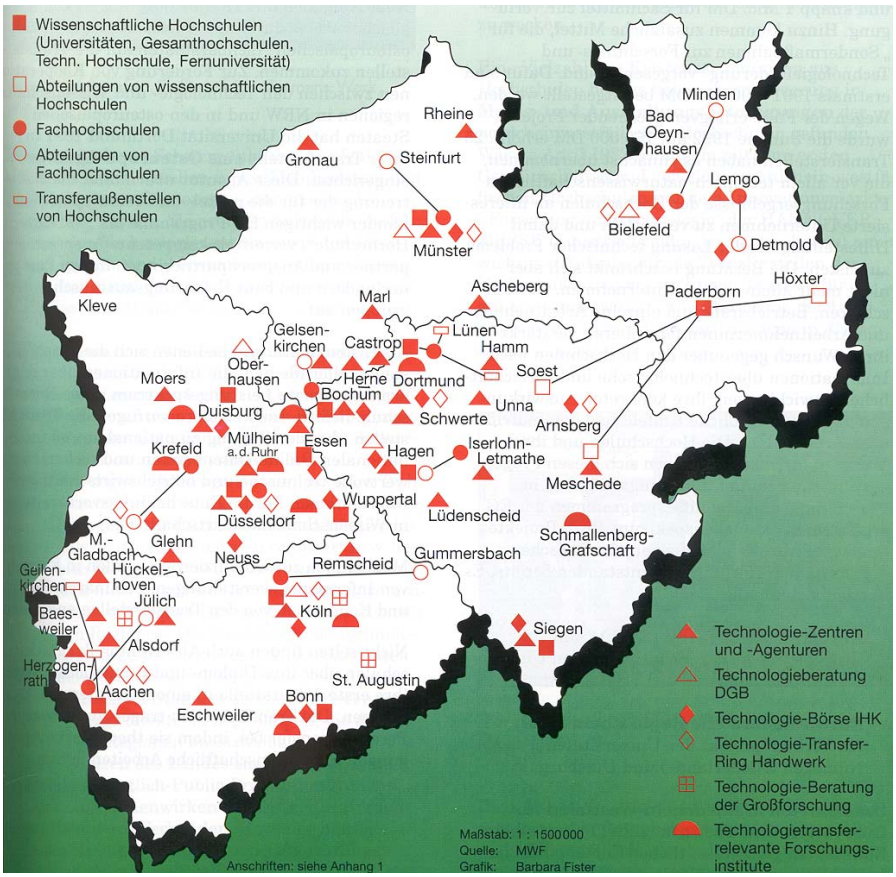
Conclusion: After 40 years of decline and diversification of the coal, iron and steel production sector no other sectors have been able to compensate for the losses in employment incurred by structural change. The regional specialisation in coal, iron and steel production is still dominant. It may be concluded, that this persistent structure makes the regional economy vulnerable against exogenous technological and market shocks. Regional policy needs to respond to this threat by the interventions aiming at the upgrading of industries technology level..

1.3.1.3 Innovation potential

As the conceptual model specifies, apart from significant differences among Objective 2 regions in terms of institutional thickness, their innovation systems may suffer from missing innovation drivers on the demand side. Barriers to innovation are determined by a lack of absorptive capacity by local firms. Especially in old-industrial areas, path-dependence from existing technological trajectories constrains product and process innovation. The following section will present statistical based arguments for the existence of demand side barriers of innovation in North Rhine-Westphalia's Objective 2 region.

The innovation system of North Rhine-Westphalia is well endowed with regional innovation and R&D infrastructures. This dense and highly developed network of universities, applied universities, technology transfer centres, and business and innovation centres is a result of development initiatives undertaken since the middle of the 1970s. As can be seen from Figure 1.4, a significant share of these infrastructures is situated in the Ruhr area.

Figure 1.4 - R&D and innovation infrastructure in North Rhine-Westphalia



Source: Bros/Walter (2000)

Despite being well equipped in terms of infrastructure and institutes, basic indicators for R&D and innovation capacity show that North Rhine-Westphalia did not particularly well in the programming period 2000 to 2006 compared to national figures or to average figures for the EU15 countries. Table 1.6 provides a comparative overview.

Table 1.6 - Basic Indicators on R&D and innovation capacity for North Rhine-Westphalia, 1995/2000/2006

Indicator	Unit	Regional			Δ(%)	National		Δ(%)	EU15		Δ(%)
		1995	2000	2006	00/06	2000	2006	00/06	2000	2006	00/06
Business enterprise expenditure on R&D – BERD	% of GDP	1	1.1*	1.1**	-1.8	1.7	1.8	1.5	1.1	1.3	18.2
Gross domestic expenditure on R&D - GERD	% of GDP	1.6	1.7*	1.8**	2.3	2.4	2.5	0.8	1.8	2	11.1
Employment in high-tech sectors on total	% on total employment	n.a	4.1	4.7	14.6	4.8	5.2	21.8	4.7	4.6	-2.1
R&D personnel in all sectors	% on total employment	n.a	n.a	1.44**	-	n.a	1.8*	-	n.a.	n.a.	-

**Data for 1999, **Data for 2005*
Source: Core team processing of Eurostat data, InTeReg processing of Eurostat data 2009

As can be seen GERD grew by 2.3 %from 1995 to 2005, but at 1.8 % in 2005 the level for North Rhine-Westphalia remained below the comparative average values for Germany and the EU15 countries. BERD even decreased for the region from 1995 to 2005 by 1.8 %; a comparatively low level.
The question of whether these unsatisfactory R&D levels North Rhine-Westphalia were influenced by poor R&D performance in the Objective 2 region can partly be answered by looking at Table 1.7.

Table 1.7 - Regional R&D intensity and R&D personnel for North Rhine-Westphalia, 2003

	Regions in Nordrhein-Westfalen			
	Ruhr area	**Rheinland**	**Westfalen**	**NRW**
	R&D Expenditure in % of GRP			
Business sector	0.7	1.5	0.8	1.1
Public sector	0.2	0.4	0.05	0.3
University Sector	0.5	0.5	0.4	0.4
All Sectors	1.3	2.4	1.2	1.8
	R&D personnel per 1,000 Inh.			
Business sector	1.4	3.0	2.0	2.2
Public sector	0.4	1.4	0.1	0.7
University Sector	1.0	1.3	0.9	1.1
All Sectors	2.7	5.7	3.1	4.1

Source: Rheinisch-Westfälisches Institut für Wirtschaftsforschung (2006).

In 2003 the value for GERD in the Ruhr area amounted only 1.3 % of GRP, staying well below the average value for the whole North Rhine-Westphalia region. At 0.7 % of GRP BERD in the Ruhr area was even lower than in the more rural area of Westphalia. On the other hand, expenditure in the university sector in the Ruhr area was slightly above the average value for Westphalia as a whole, and equal to that of the otherwise strong Rheinland region. R&D personnel as a second input indicator provides additional insight in this issue. With 2.7 persons per 1,000 inhabitants in 2003, the Ruhr area has the lowest density of all North Rhine-Westphalian regions. The respective value for the business sector is even more striking: in the Ruhr area only 1.4 persons per 1,000 inhabitants were working on R&D compared to the average value of 2.2 for North Rhine-Westphalia as a whole.

A look at the output side of the regional R&D system can help to get an even clearer picture of the prevailing challenges for innovation policy in the Objective 2 area of North Rhine-Westphalia. Table 1.8 presents data on patent applications filed at the German national patent office (DPMA) in the year 2005. Growth rates are also indicated for the time-spans of 2000 to 2005 and 1995 to 2003.

Table 1.8 - Patent applications at DPMA for North Rhine-Westphalia, Ruhr area in interregional comparison 2005.

Region / Bundesland	Patent Applications					
	DPMA patent applications 2005	in % of total applications	Growth p.a. 2000-2005 in %	Patent-intensity	Germany = 100	Growth p.a. 1995-2003 in %
Baden Württemberg	12,828	26.5	0.5	1,201	205	0.2
Bayern	13,688	28.3	0.6	1,104	188	0.2
Nordrhein-Westenfalen	8,151	16.9	-4.6	451	77	-4.7
Ruhr area	1,459	3.0	-2.8	274	47	-2.7
Rheinland	4,353	9.0	-6.2	571	97	-6.4
Westfalen	2,339	4.8	-2.5	456	78	-2.7
Germany	48,367	100.0	-2.0	586	100	-2.1

Source: Rheinisch-Westfälisches Institut für Wirtschaftsforschung (2006).

As can easily be seen, the findings from the analysis of input indicators are reflected in the output (or in terms of innovation policy throughput-) data. In 2005, North Rhine-Westphalia had a patent intensity[3] of 451, thus remaining below the German average of 586. Comparable values for the other large German federal states reveal even greater disparities: Baden Württemberg recorded a patent intensity of 1,201, while the value for Bavaria was 1,104. Again, it can be shown that the Ruhr area performed particularly poorly, with a patent intensity of 274, even lower than the already low average value for North Rhine-Westphalia. Growth rates of patent applications for North Rhine-Westphalia and the Ruhr area were negative both for in 1995 to 2003 and 2000 to 2005. The smaller rates of decrease for the Ruhr area are mainly the result of the already existing low level of patenting activities.

Based on the above figures, the structural policy challenges for the Objective 2 region appear obvious. Since the region is endowed with a well developed R&D infrastructure, clearly visible in terms of R&D expenditure, there is a strong need to further increase the supply of applied R&D, and in parallel, to foster stronger links in the region between industry and science.

Conclusion: Barriers to innovation do prevail in North Rhine-Westphalia's Objective 2 region on the demand side for R&D results. Firms show poor absorptive capacities in terms of R&D personnel and expenditure, and patent applications. The regional specialisation in coal, iron and steel production seems to influence regional innovation potential negatively. Based on a very good endowment with regional R&D infrastructure ways for better exploitation of R&D results have to be sought after in the objective 2 region.

1.3.2 Understanding the geography of structural change

Looking at the region of North Rhine-Westphalia as a whole, complementary specialisations between the Ruhr area and the other regions in North Rhine-Westphalia can be observed: while the Rheinland has a high

[3] Number of patent applications per 1 million inhabitants

concentration of higher value production oriented services, this is to much less true for the Ruhr area; the same trend can be seen with respect to the development of new technologies. The region around Aachen, with its technical university, and the area of Cologne, with its media cluster, are much more dynamic (Bros/Walter 2000, p. 13). In addition, local disparities hold true within the Ruhr area itself. Individual cities, such as Dortmund, mastered the recent transition process far better than others (Butzin 1993, p. 11).

Since the mid 1990s, several studies on new production clusters in the Ruhr area and North Rhine-Westphalia have pointed to newly emerging sectors such as the environmental industry, media technology and the social care cluster (e.g. Rehfeld 1995, p. 92; Heinze et al. 1998). Also, in addition to environmental technology, other new technologies are playing an increasing role in the region's economy, i.e. new materials, manufacturing technology, and power engineering (Dege/Kerkemeyer 1993, p. 504). In 1999, Roland Berger & Partners was appointed by the regional government to identifying competence fields in North Rhine-Westphalia. Based on their analysis six latent or potential clusters[4] were identified: Energy Technology, Logistics and Mobility, Information and Communication Technologies, Medical Technology, New Materials, and Micro-Technology (Roland Berger Strategy Consultants 2001). The results of this study were integrated into the overall strategy of the SPD 2000-2006 for North Rhine-Westphalia. The identification of potential regional clusters went still further on the level of the Objective 2 region, along with public discussion of the implementation of the 'Wachstums- und Beschäftigungspakt Ruhr' (Regional Alliance for Jobs and Economic Growth of the Ruhr area). Thus in 2001 the following fields were added to the existing list: chemistry, tourism, water technology, machinery and equipment, design, industrial technology and materials, and mining engineering (Wachstums- und Beschäftigungspakt Ruhr 2001). Based on discussions among regional policy actors and on practical experience in the funding of projects this regionalised list was later modified: medical technologies was enhanced by health services and social care; mining engineering, machinery and equipment and new materials were merged into industrial technologies, and water technology was integrated into energy technology.

Conclusion: The concept of clusters has been identified in North Rhine-Westphalia as a viable instrument to overcome prevailing patterns of regional specialisation and barriers to innovation. Regional policy needs to address these emerging technology fields by adopting a synergic mix of interventions ranging from the development of physical and R&D-infrastructure to promotion of regional networks.

[4] Latent clusters are characterised by a critical mass of regional firms but poorly developed inter-firm co-operations; potential clusters are characterised by the incomplete presence of constituting elements of functioning clusters (Rosenfeld 1997, Enright 2003).

2. Regional policy 2000-2006: strategy and objectives

2.1 Regional policy mix for structural change and globalisation

Regional structural policy (NUTS 1 level) and associated measures have been used in North Rhine-Westphalia since the late 1960ies. Thus the Objective 2 programme fits into a long tradition of regional policy strategies and concepts dealing with structural change. Table 2.1 provides an overview of relevant past programmes:

Table 2.1 - Regional structural policy programmes in North Rhine-Westphalia before the programming period 2000-2006

Time period	Programme	Budget
1968-1973	Entwicklungsprogramm Ruhr	ca. 17 bill. DM
1970-1975	Nordrhein-Westfalen-Programm	ca. 31 bill. DM
1974-1984	Technologieprogramm Bergbau	ca. 0.6 bill. DM
1974-1984	Technologieprogramm Energie	ca. 1.6 bill. DM
seit 1978	Technologieprogramm Wirtschaft	1978-1984 ca. 0.35 bill. DM
1979-1989	Technologieprogramm Stahl	ca. 0.5 bill. DM
1980-1984	Aktionsprogramm Ruhr	ca. 7 bill. DM
1987	Zukunftsinitiative Montanregionen Zukunftsinitiative für Regionen NRW's Landesinvestitionsprogramm	
1992-1995	Handlungsrahmen Kohlegebiete	ca. 1 bill. DM
1994-1997	Gemeinschaftsaktion Industriestandort NRW	ca. 2 bill. DM

Source: Heinze et al. (1996)

Since 1989, ERDF funding in North Rhine-Westphalia has also been part of the regional policy mix aiming to meet the challenges of structural change. Relevant regional programmes have thus been combined and complemented by measures under ERDF funding. Until 1999 only cohesion policy objectives had been addressed but it is noteworthy that in 2000 with the introduction of the Lisbon and Goteborg Agenda an integrative programming approach addressing multiple dimensions of structural change – including RTDI policy priorities and measures – has also been possible.

The Objective 2 programme 2000-2006 is embedded in a complex policy framework with programmes and instruments in place, both at federal and regional level:

- At federal level (in cooperation with the Bundesländer) in particular the Gemeinschaftsaufgabe "Verbesserung der regionalen Wirtschaftsstruktur" (Joint Agreement for the Improvement of Economic Structures) with its 31st and 32nd framework plan, has been used to apply mainly traditional instruments, such as promotion of firm investment. At regional level, funding of the federal-regional programme and ERDF funding have been combined in several measures.

- Federal programme measures in the domain of RTDI policy also aim at issues of structural change; a concrete example here is the programme EXIST, hosted by the German Federal Ministry of Economy (promotion of academic spin-offs) which is also subject to co-financing with ESF funding.
- At the level of North Rhine-Westphalia the regional programmes "Technologie- und Innovationsprogramm NRW" (Technology and innovation programme), "Beratungsprogramm Wirtschaft", "Gründungsoffensive NRW" (regional initiative for the promotion of start-ups) were implemented in the timeframe of the programming period 2000-2006. As with federal programmes, combination of regional programmes and ERDF funding was undertaken in several measures.

2.2 Overall strategy of the 2000-2006 Objective 2 programme

Since the economic history of North Rhine-Westphalia provides a blueprint for the transition process of an old industrial area, regional policy (and in particular ERDF programming) has put a strong emphasis on the issue of structural change. Thus the operational programme for the programming period 2000-2006 can be seen as an integrative strategic approach designed to tackle the multidimensional effects of structural change at regional level. Starting from a thorough analysis of different at regional level (a major focus was placed on the Ruhr area, an old industrial area) three Priority Axis were derived, with a particular emphasis being placed on challenges associated with structural change. The following dimensions are covered:

- Socio-economic change and human capital: Problems associated with this dimension are addressed specifically in the sections on socio-economic analysis (i.e. section 1.2). The development of unemployment is dealt with in section 1.3., while labour market and qualification patterns associated with old industrial areas are analysed and discussed in section 3.1.
- Regional specialisation is dealt with in the sub-sections on sectoral economic structure and development trends (section 1.1.2 to section 1.2.4) of the Objective 2 area. In addition to generic issues such as structure, firm size and firm formation rates, as well as sectoral issues (coal, iron and steel production, energy production, services) are also covered.
- The regional production system is addressed only implicitly in economic and socio-economic analysis; the economic history of the last 20 years shows a clear transition from large scale integrated coal, iron and steel production, to more diversified small and medium sized enterprises.
- Innovation potential is explicitly addressed in an individual section on technology and innovation and is placed within the broader framework of an analysis of current regional competitiveness and infrastructure development.
- Globalisation and relocation are neither explicitly nor implicitly addressed. In fact the SWOT analysis of the programming document highlights the very large endogenous market as a regional strength (i.e. 5.1 million people living in the Objective 2 region and 18 million inhabitants in the whole of North Rhine-Westphalia).

In total three out of four priority axes in the programming document provide measures to tackle the challenges of structural change (only Priority Axis 4 "target group oriented measures" is oriented towards a different strategic direction):

- Priority Axis 1 "Financing of Start-ups and Enterprises" tackles the issue of structural change in the sense of measures and policy instruments applied in a traditional way. Interventions focus on the one

hand on the stimulation of investments at firm level in order to stimulate economic growth (Measures 1.1, 1.2), and on the other hand, emphasize the promotion of start-ups (Measures 1.3, 1.4).

- Priority Axis 2 "Innovation and competence development" provides a more innovative approach to planned interventions. Here the impact of the Lisbon and Goteborg agenda is clear. Soft measures dealing with organisational innovations (Measure 2.3) or with consulting services for start-ups (Measure 2.2) are represented as well as measures addressing specific potential future clusters (Measure 2.5, 2.8, 2.11); in addition, Measure 2.1 also fosters industry science links.
- Priority Axis 3 is also innovative, but provides a different flavour to regional development than Axis 2. Emphasis is here put on innovation and technology infrastructures in the Objective 2 area (Measure 3.3), on the development of logistic infrastructures (Measure 3.4), and on the reactivation of old brown fields in the shape of science- and technology parks (Measure 3.1). All measures aim to provide possibilities for integrated, value chain oriented projects, involving regional SMEs and start-ups.

Table 2.2 - Overview of the Objective 2 programme

	Brief description and objective	Budget (Euros, and % of total budget)
Overall programme	Integrative strategic approach to address the challenges of structural change: Improvement of the competitiveness of regional economy, activation of potentials for endogenous growth, and improvement of infrastructure	Total public funding: EUR 1,889,942,023 ERDF funding: EUR 765,767,777
Axis 1: Financing of Start-ups and Enterprises	Promotion of SME investment activities; including the formation of new start-ups	EUR 114,711,334 Share of ERDF budget: 15 %
Axis 2: Innovation and Competence Development	Improvement of regional competitiveness by providing soft measures, R&D grants and indirect promotion instruments to firms and other actors in the regional innovation system	EUR 298,973,530 Share of total budget: 39 %
Axis 3: Innovative Infrastructure development	Development of regional technology and innovation infrastructure; promotion of investment in regionally integrated training and qualification infrastructures	EUR 286,407,555 Share of total budget: 37.4 %

The programme strategy 2000-2006 makes use of complementarities between ERDF and ESF in all four priority axes: in Axis 1, we have Measure 1.5 "Wage subsidies for the reintegration of the unemployed and those threatened by unemployment" (Lohnkostenzuschüsse für Arbeitslose und von Arbeitslosigkeit bedrohte), in the Axis 2, Measure 2.10 "Labour market policy support for enterprise development", in Axis 3, Measure 3.5 "Combined promotion of employment and infrastructure", and in Axis 4, Measure 4.2b "Integrated development of urban problem areas".

The programme strategy 2000-2006 for North Rhine-Westphalia can be seen as an integrative strategic approach which continues a 20 year effort to transform an old industrial area (traditionally focussing on coal, iron and steel production) into a modern, diversified industry and service location. As specific path dependencies have been shaping the agenda of regional policy for decades, several dimensions of structural change are dealt with. The programming strategy is thus closely interlinked and adjusted to other regional policy programmes, both in the domain of regional policy (i.e. Regionales Wirtschaftsförderungsprogramm

Nordrhein-Westfalen) as well as in regional innovation and technology policy (i.e. Technologie- und Innovationsprogramm NRW).

2.3 Selected fields of intervention and measures

2.3.1 Selection logic

As section 1.3 shows, North Rhine-Westphalia's Objective 2 region faced in the programming period 2000 to 2006 challenges in the domains of regional specialisation and innovation potential. The region was still dominated by its coal, iron and steel industry. As a result absorptive capacities for R&D results remained underdeveloped compared to the whole of Germany. Measures relevant for the case study thus should directly address the problems described above.

The integrative approach of the overall programme strategy meant that a large number of interventions was explicitly or implicitly addressing the different dimensions of structural change: in total, 12 measures dealt with structural change issues in the programming period 2000 to 2006 (see Table 2.3). In particular structural change such as regional specialisation, innovation potential, and socio economic change and human capital were addressed. In addition, one measure (Measure 2.3) covered the issue of globalisation.

Table 2.3 - Measures with relevance to the cluster / competence field development approach

Measure	Relevance in the programming document	Relevance in implementation
1.1. Promotion of firm investments in SMEs	----	Implicit ++
1.3 Promotion of academic spin-offs	----	Not implemented / merged with 2.2
1.4 Promotion of start-ups in crafts sector	----	----
2.1 Fostering of firm's innovation capacities	Explicit	Implicit ++
2.2 Regional Start-up promotion campaign	----	----
2.3 Strategy development in SMEs	----	Implicit 0
2.5 Development of the media sector	Explicit	Explicit ++
2.8 Development of the energy sector	Explicit	Explicit ++
2.11 Development of the health sector	Explicit	Not implemented
3.1 Reactivation of brownfields	Explicit	Explicit ++
3.3 Development of the regional innovation infrastructure	Explicit	Explicit ++
3.4 Development of the logistics sector	Explicit	Explicit ++

Legend: ---- = not relevant; 0 = neutral; + = relevant; ++ = very relevant
Source: Ridder et al. 2005b.

The newly introduced cluster development approach responded to the identified policy challenges in an integrative fashion. The approach was regarded as a tool to tackle the persistent regional problems in parallel. In addition it formed a unifying framework for the whole programming strategy. Table 2.3 provides an overview of the relevance of the competence field to the specific measures. As can be seen above

measures under Priority Axis 2 and 3 were explicitly aligned towards the cluster development approach in programme strategy as well as towards implementation of policy interventions.

Since the new cluster approach played a central role in the overall programming strategy, the selection of measures for in depth analysis needs to take their relevance for competence field development into account.

Taking into account the working hypotheses established in section 1.3, and the cluster development approach as an underlying theme for the whole programming period, we arrive at the selection of measures for the field work[5]:

- **Measure 2.8 – development of the energy sector** puts a different perspective on policy responses to persistent regional specialisation. Since the energy technology and production sector has been identified as a highly promising field for cluster development, Measure 2.8 will be selected as a concrete case. In particular, the question of whether a synergetic combination of different interventions within the measure (i.e. development of pilot and demonstration projects, development of thematically centred R&D institutes, support for innovation projects) was successful in seeding the nuclei for future cluster development in order to overcome regional lock-in effects and poor innovation performance will be addressed. This requires analysis of innovation potential and of cluster support mechanisms.
- **Measure 3.3 – technology infrastructure**: this was the largest single measure in terms of total budget share (16.8 % of overall funding) in the programming period 2000 to 2006. The measure is selected for it addressed directly the regional innovation potential (since new competence and applied R&D centres can actively contribute to improved industry-science co-operations). The analysis of Measure 3.3 sheds light on the hypotheses concerning the domains of innovation potential and of regional cluster development, but does this from a different angle than that of Measure 2.8: while the former supported projects in several emerging competence fields, the second was confined to energy technologies. Thus, the assessment of Measure 3.3 is aimed at identifying the contributions of the selected intervention to cluster development for a thematically less focussed setting.

[5] The chosen measures were discussed with regional policy makers; the selection of measure 2.8 is a result of this discussion process.

Table 2.4: Measures relevant with respect to structural change and globalisation: main features

Measures	Brief description (including date of implementation)	Financial weight		N° of projects / beneficiaries	Type of intervention	Structural change dimension	Relevance for structural change and globalisation *
		% tot. budget	% absorption				
Meas. 1.1	Promotion of firm investments in SMEs (date of implementation 2000-2006)	3.6	98.6	408 projects	Business support (i.e. direct aid to SME s)	socio-economic change and human capital	*
Meas. 1.3	Regional Start-up promotion campaign / Promotion of academic spin-offs (date of implementation 2005-2006; in 2005/6 merger with Measure 2.2)	-	-	-	Business support (i.e. direct aid to SME s)	regional specialisation innovation potential	***
Meas. 1.4	Promotion of start-ups in crafts sector; promotion of start-ups in all economic sectors (date of implementation Meistergründungsprämie 2000-2003; date of implementation Gründungsprämie 2003-2006)	1.6	100.0	Meistergrün-dungsprämie: 469 beneficiaries Gründungs-prämie: 2,630 beneficiaries	Business support (i.e. indirect aid to SME s)	socio-economic change and human capital	**
Meas. 2.1	Fostering of firm innovation capacities, stimulation of industry-science co-operations (date of implementation 2001-2006)	11.7	104.3	259 projects	Technology and innovation (i.e. direct grants)	innovation potential	***
Meas. 2.2	Regional start-up promotion campaign (start date 2000; merged in 2005/6 with Measure 1.3)	2.7	99.6	59 projects	Technology and innovation	regional specialisation	***
Meas. 2.3	Strategy development in SMEs (i.e. management, marketing and internationalisation) (date of implementation 2000-2006)	4.0	99.6	54 projects	Business support (i.e. soft measures for SME s)	Internationalisation and relocation	**
Meas. 2.5	Development of the media sector as a field of technological competence (date of implementation 2001-2006)	0.9	102.3	32 projects	Technology and innovation (i.e. direct grants)	Regional specialisation, innovation potential	***
Meas. 2.8	Development of the energy sector (i.e. cluster development) (date of implementation 2000-2006)	3.4	106.6	59 projects	Technology and innovation (i.e. direct grants)	Regional specialisation, innovation potential	***
Meas. 2.11	Development of a new technological field of competence (i.e. cluster) in the field of health technologies and services (cancelled 2005 after	-	-	-	Technology and innovation (i.e. direct grants and	Innovation potential, regional specialisation	***

Measures	Brief description (including date of implementation)	Financial weight		N° of projects / beneficiaries	Type of intervention	Structural change dimension	Relevance for structural change and globalisation *
		% tot. budget	% absorption				
	rejection of the O.Vision project)				indirect measures)		
Meas. 3.1	Reactivation of brown fields, development business and industry settlement areas (date of implementation 2000-2006)	16.0	105.5	59 projects	Infrastructure investments (i.e. socio-economic Infrastructure)	Regional specialisation	***
Meas. 3.3	Development of the regional innovation infrastructure, interlinking with regional fields of technological strength (date of implementation 2000-2006)	16.8	113.1	103 projects	Infrastructure investments (i.e. socio-economic infrastructure)	Innovation potential, socio-economic change and human capital	***
Meas. 3.4	Development of the logistics sector in the programme area (date of implementation 2000-2006)	2.0	101.5	38 projects	Infrastructure investments (i.e. transport), Business support (i.e. direct aid to SMEs)	Regional specialisation, innovation potential	***

*Legend: * marginally relevant, ** relevant, *** extremely relevant*
Source: Ziel 2 Pogramm 2000-2006 Ergänzungsdokument (2004), Ministerium für Wirtschaft, Mittelstand, Energie des Landes Nordhrein-Westfalen (2007).

2.3.2 Detailed description of the selected measures

2.3.2.1 Measure 2.8 Future technologies in the energy sector

Measure 2.8 aimed at the development of a regional competence cluster for future-related energy technology and production, and was based on the existing endogenous competences in the Ruhr-area. In order to reach the defined goals, policy objectives from the domains of structural policy, industry policy, technology policy, labour market policy, energy policy and environmental policy were suitably aligned and adjusted. The focus was placed on the following technology fields: photovoltaics, fuel cells, bio-energy und geothermal energy. The measure also contributed to the process of structural change in the energy sector, resulting from the liberalisation of the European energy market. The integrated framework ensured that several existing and new policy measures were bundled to produce more rational energy use and to promote the diffusion of renewable energy technologies at a strategic level. The measure aimed at the development and strengthening of the regional competences in the energy sector, the protection of existing jobs/creation of new jobs in enterprises of the energy producing sector, the improvement of regional competitiveness by reducing energy costs, the improvement of efficiency in energy production, reduction of resource consumption, and the reduction of carbon dioxide emissions of and of other substances relevant to climate change.
Funding activities for the measure were carried out on the basis the following regional programmes: REN-(Rationelle Energieverwendung und Nutzung unerschöpflicher Energiequellen) Technische Entwicklung (rational energy use - technology development), REN-Demonstrationsförderung (rational energy use - pilot and demonstration projects), REN-Breitenförderung (rational energy use - funding of small projects), and REN-Ausbau der Kraft- Wärme-Kopplung und der Nah- und Fernwärme (rational energy use - regional energy supply). The funding rate for the measure was 50 % of the eligible project costs (i.e. physical investments, R&D project costs, services). Target groups addressed were private enterprises, (in particular SMEs), public and municipal enterprises; project development organisations, and R&D institutes and universities.

2.3.2.2 Measure 3.3 Technology and Qualification Infrastructure

In the preceding programming periods after 1989 a dense network of regional incubators, technology parks, and training infrastructures was created. In the programming period 2000-2006 a new perspective was added to the existing activities. In order to support the development of regional clusters, structures complementary to existing infrastructure, modernisation projects and training centres were the focus of funding activities. Thus, Measure 3.3 aims further at the development of competences in regional technology fields, economic exploitation of regional technological competences, the development of a clear cut technology profile for the region, the enhancement of industry related applied R&D institutions·(and of their personnel), the increase in the number of regional new technology based firms, and the creation of new training facilities and or modernisation of existing training facilities.

The Measure 3.3 comprises the following elements:

- Support of the technology oriented, competitive call for future ideas in Measure 2.1, by means of funding R&D infrastructures in industry-related R&D institutes.
- Demand oriented and regionally co-ordinated development of complementary technology and qualification infrastructures with the overarching aim of strengthening and developing regional technological competences. Infrastructure related support of other measures in the programming area (i.e. start-up, promotion of SMEs).
- Modernisation and improvement of the technological endowment of already existing technology and qualification infrastructures; major emphasis is put on state-of-the-art ICT infrastructures.
- Development of a network of existing technology and qualification infrastructures in order to improve the overall efficiency of the innovation system and to foster industry-science co-operation, technology transfer, and to improve the supply of services and information for enterprises and new technology based firms.

Funding activities for the measure were carried out on the basis of the following regional programmes: "Technologie- und Innovationsprogramm NRW" (Technology and innovation programme); "Regionales Wirtschaftsförderungsprogramm des Landes Nordrhein-Westfalen" (regional economic development programme); "Richtlinien über die Gewährung von Zuwendungen für modernisierungs-, struktur- und zielgruppenbezogene Arbeitsmarktmaßnahmen" (regional labour market policy programme). The funding rate of this measure was on average 38.5 % of the eligible costs. In addition to technology centres and incubators, target groups also included universities and applied research organisations, inter-firm vocational training institutions, and training and qualification institutions involved in lifelong learning.

3. Effects of the selected ERDF measures on the process of structural change and adaptation to globalisation

This section offers an assessment of the contribution of the measures selected in section 2.3 in promoting structural change and enabling adaptation to globalisation (section 3.1). It also explores the qualitative effects achieved by the programme (section 3.2).

3.1 Assessment of the structural and socio-economic effects

3.1.1 Performance of selected measures

Measure 2.8: Competence and cluster development energy and energy technology

The funding period for Measure 2.8 began late on 11th December 2001, since the Technologie- und Innovationsprogramm (Technology and Innovation programme) was not notified by the European Commission until the beginning of December 2001. In 2005, the measure was subject to the mi-term revision under the Objective 2 programme. Funds were reduced by € 6.0 million, and values for programme indicators were reduced accordingly (see Table 3.1 and 3.2):

Table 3.1 - Measure 2.8 - comparison of selected planned and realised financial and material indicators (initial values)

Indicator	Planned (2006)	Realised (2000-2006)	Ratio realised/planned
Input public funding (€ million)	75.3	61.5	81.6
Input ERDF funding (€ million)	37.6	30.5	80.9
Total project costs (€ million)	187.6	129.0	68.8
Private investments induced (€ million)	112.3	67.6	60.2
CO2 reduction in tons per year	523,550	144,456	27.6
Number of jobs created in total	4,443	328	7.4
Number of jobs secured in total	2,222	849	38.2

Source: Annual report (2005).

Within Measure 2.8 a total 59 projects, with an overall volume of € 153.3 million were funded in the period from 2001 to 2006. Taking into account the reduction of funds for Measure 2.8 as a result of the mid-term revision of the Objective 2 programme in 2005 - the measure managed to reach its material targets for total funding and ERFD funding (see Table 3.2).

Table 3.2 - Measure 2.8 - comparison of selected planned and realised financial and material indicators (revision of planning in 2005)

Indicator	Planned (2006)	Realised (2000-2006)	Ratio realised/planned
Input public funding (€ million)	66.3	70.7	106.6
Input ERDF funding (€ million)	35.1	35.2	100.3
Total project costs (€ million)	165.2	153.3	92.8
Private investments induced (€ million)	98.9	82.6	83.5
CO2 reduction in tons per year	460,970	144,971	31.4
Number of jobs created in total	3,912	392	10.0
Number of jobs secured in total	1,956	998	51.0

Source: Annual Report (2006).

In terms of project content the distribution of funded projects is as follows: 32 projects focussed on technology development, representing thereby about 44 % of the total project costs (about € 68 million). 14 funded projects were demonstration projects, with a share of 35 % of total project costs; while energy related studies and concepts (11 projects), internationalisation (3 projects) and other funding activities (1 project) were only of minor relevance. The technology projects included fuel cells (20 projects), combined heat and power generation (13 projects), bio-energy (12 projects), photovoltaics (11 projects), and geothermal energy (8 projects). A further 24 projects could not be classified according the established categories. The projects induced substantial innovations: 47 new processes and 44 new products have been developed by 2006.

Under Measure 2.8 ERDF funds of € 35.2 million resulted in private investments worth of € 82.7 million in total, and total investments of € 153.3 million, thus providing a leverage ratio of 2.4 for private investments and 4.4 on the total investments induced. Although quite effective in terms of induced investments, the measure did fall short of its material objectives with respect to intended labour market effects. Only 10 % of the initially planned new jobs could be realised; also the securing of existing jobs turned out to be unsatisfactory (51 % of the original target value was reached). The target for carbon dioxide reduction could also not be reached, and only 31.4 % of the initial target value had been realised by the end of the programming period.

Thus, the updated midterm evaluation concludes that expectations in terms of increased firm competitiveness and employment were unrealistic for such an emerging, new technology field. In particular the chosen focus on hydrogen and fuel cells addresses technology in a pioneering phase facing high uncertainties and a strong need for basic and applied research. Nevertheless, the midterm evaluation also concluded that the measure managed to build a sturdy basis in terms of R&D capacity for the future development of a competitive regional firm base in the energy sector (Ridder et al. 2005).

Measure 3.3: Technology Infrastructure

By spring 2005 the initially planned amount available for public funding in Measure 3.3 had already been exhausted (see Table 3.3). Due to the continuing high demand for funding, the total budget for the measure was thus increased by about € 20 million, upon the mid-term revision of the Objective 2 programme in 2005.

Table 3.3- Measure 3.3 - comparison of selected planned and realised financial and material indicators (initial values)

Indicator	Planned (2000-2006)	Realised (2000-2005)	Ratio realised/planned
Input public funding (€ million)	293.6	312.4	106.4
Input ERDF funding (€ million)	119.4	107.8	90.3
Total project costs (€ million)	349.8	321.0	91.8
Private investments induced (€ million)	56.2	8.6	15.2
Total size technology infrastructures in m2	64,440	79,096	122.7
Total size of qualification and training infrastructure in m², created or modernised	784,020	88,934	11.3
Number of training and qualification places created or modernised	17,721	15,303	86.4

Source: Annual Report 2005.

In the programming period 2000 to 2006 a total of 103 projects with total costs of € 369.5 million received funding. All public funds available were absorbed by beneficiaries. The number of projects was unevenly distributed between technology and qualification infrastructures (ratio 30:73), technology related capacity building accounted for more than 60 % of the project costs. In addition the development of technology infrastructures was dominated by large scale projects, which absorbed larges shares of the funding available (i.e. MST. Factory, BiomedizinZentrum Dortmund etc.). In total, investments of € 369.5 million were induced by the ERDF funding earmarked (€ 133.9 million) for this measure. Nevertheless, it has to be noted that only € 1.7 million stemmed from the private sector. The leverage ratio for total investments induced was thereby 3.0.

Table 3.4 - Measure 3.3 - comparison of selected planned and realised financial and material indicators (revision of planning in 2005)

Indicator	Planned (2006)	Realised (2000-2006)	Ratio realised/planned
Input public funding (€ million)	325.3	367.8	113.1
Input ERDF funding (€ million)	132.9	133.9	100.8
Total project costs (€ million)	387.6	369.5	95.3
Private investments induced (€ million)	62.4	n.a.	n.a.
Total size technology infrastructures in m²	n.a.	84.976	n.a.
Total size of qualification and training infrastructure in m², created or modernised	714,396	102,000	14.3
Number of training and qualification places created or modernised	19,634	17,489	89.0

Source: Annual Report (2006)

In effect, in the programming period from 2000 to 2006 the supply of regional technology infrastructure was significantly higher than initially intended (i.e. 122.7 % of the planned square-meters were already realised by 2005). In contrast the planned new or modernised qualification infrastructures in the same time-span only reached 11.9 % of the initial target value. The number of created or modernised qualification and training places was 89.0 % of those planned.

The midterm evaluation reached the conclusion that Measure 3.3, in the domain of qualification and technology infrastructure development, contributes strongly to the intended overall goals of the programming document. Nevertheless, it is noteworthy that in the course of its implementation, the main emphasis was put on the creation of new technology and qualification capacities, while the intended new strategic focus on upgrading and more efficient use of already established infrastructures was given less weight in the programming period 2000 to 2006 as initially intended. The idea of establishing a network of firms and technology infrastructures in the Objective 2 region (in combination with Measure 2.1) was not pursued strongly enough either; thus the aim of improved technology and knowledge transfer with regional innovation infrastructures as major interaction nodes was not achieved, as initially hoped. From the perspective of efficiency and effectiveness, however the fact that new infrastructures are aligned to the competence and technology fields of the region deserves positive comment (Ridder et al. 2005).

3.1.2 Contribution of selected measures to structural change and globalisation

Measure 2.8 Competence and cluster development in the energy sector

Background

Influenced by its economic history, the Ruhr area possesses comparative advantages in traditional energy production (Rheinisch-Westfälisches Institut für Wirtschaftsforschung et. al 2006). In 2001 about 28 % of the electricity produced in Germany originated from North Rhine-Westphalia, with coal accounting for 87 % of the fuel input for production (Landesregierung Nordrhein-Westfalen 2006). The regional firm base in the technology fields associated with renewable energy production in North Rhine-Westphalia developed rapidly in the period 2000-2006. Table 3.5 provides an overview of the structure and growth of turnover and employment from 2000 to 2006 both differentiated by technology fields and as a whole.

Table 3.5 - Turnover and employment in the renewable energy sector in North Rhine-Westphalia 2000-2006

	Turnover					Employment				
	Mill. €			in %		Numbers			in %	
	2000	2004	2006	2007	2000/200	2000	2004	2006	2006	Δ 2000/2006
Wind energy	643.4	745.7	1,030.8	28.9	60.2	2,414	3,336	3,629	31.4	50.3
Bio energy	199.3	324.5	705.2	19.7	253.8	758	1,313	2,234	19.3	194.7
Solar heating	68.3	105.2	314.3	8.8	360.2	864	912	1,396	12.1	61.6
Photovoltaics	137.2	515.6	1,019.3	28.5	642.9	721	1,253	1,665	14.4	130.9
Solar technical firms		14.0	30.0	0.8			64	236	2.0	
Solar architecture	7.2	15.2	16.4	0.5	127.8	148	172	192	1.7	29.7
Hydroelectric electric	15.1	7.2	9.0	0.3	-40.4	140	99	104	0.9	-25.7
Geothermal energy	5.5	11.4	118.3	3.3	2050.9	89	159	399	3.5	348.3
Combined heat and p	66.4	99.7	139.2	3.9	109.6	314	461	466	4.0	48.4
Services	63.7	168.4	180.2	5.0	182.9	539	725	938	8.1	74.0
Fuel cell		5.6	8.5	0.2			201	298	2.6	
Total	1,206.1	2,012.5	3,571.0	100.0	196.1	5,987	8,695	11,557	100.0	93.0

Sources: IWR 2003, IWR 2006, own computations

In total the sector grew significantly in the time-span considered, almost doubling its employment from the beginning of the programming period in 2000. Turnover grew even more, by 196.1 % in the same period. Subsectors of particular importance in terms of employment (in 2006) contained firms involved in the production of wind energy plants (31.4 %), bio-energy technologies (19.3 %), and photovoltaics (14.4 %). Employment figures for firms involved in the development of fuel cells are only available for the period after 2003. Even here, however, employment grew within the two years observed by 48.1 %. The figures for turnover for all technology fields reveal a similar pattern. It can be seen that the demand for technological knowledge in the renewable energy sector in the regional innovation system grew considerably during the programming period in focus.

These initial conditions led, supported by an analysis of potential clusters in North Rhine-Westphalia by Roland Berger & Partner in 1999, to the decision to promote the development of a regional competence field in the energy sector. The planned intervention was able to build upon already ongoing regional activities: In 1996 the regional ministries for energy, science and for the environment started the "Landesinitiative Zukunftsenergien Nordrhein-Westfalen" (i.e. regional public initiative for the promotion of new forms of energy production) in order to foster structural change in the energy technology and production sector. Within the framework of this initiative, the regional programme for the promotion of rational energy use and the increased diffusion of renewable energy technologies was initiated and implemented from the same year on. It is also noteworthy in this respect that the mid-term evaluation identified an increased need for better industry-science co-operations in the renewable energy sector (IAT, ÖIR, EPRC 2003).

ERDF interventions under Measure 2.8 in the programming period 2000 to 2006 generally aimed at co-funding the above mentioned ongoing regional programmes and initiatives for the whole of North Rhine-Westphalia, under the umbrella of the "Landesinitiative Zukunftsenergien Nordrhein-Westfalen". Large scale projects accounted for 60.0 % of the total investments induced (see Table 3.6).

Table 3.6 - Large scale projects funded within Measure 2.8

Year	Project title	Total costs in € million
2001	Centre for Fuel Cell Technology (ZBT GmbH)	11.44
2002	Construction and testing of a biomass energy power plant	27.20
	Fuel cell systems for mining	4.5
2003	Energy related advisory services for SMEs	6.8
	Energy savings with the use of high temperature processes for dye production	13.6
	Large scale integrated photovoltaic cells in the roof of a storage hall	4.1
2004	Development of steam turbines	7.3
	"Blue Tower" – large scale pilot plant for processing biomass into hydrogen (in the Hydrogen park Herten)	14
2005	Consulting project for passive energy management as part of old building renovation	3.01
2006	BEGIN – Basic technologies and development of gas turbines	13.5

Sources: Ministerium für Wirtschaft und Mittelstand, Energie und Verkehr des Landes Nordrhein-Westfalen 2001, 2002, 2003, 2004a, 2005, 2006

The envisaged competence field development was pursued in two directions: Firstly large scale projects were intended as pilot and demonstration activities for new promising energy technology applications, in

addition also new elements of regional R&D infrastructure in the energy sector were developed. Secondly the development of industry–science networks was supported by the initiation of thematically focussed "competence networks" under the umbrella of the "Landesinitiative Zukunftsenergien Nordrhein-Westfalen".

Infrastructure projects as future cluster nodes

Firstly the role of infrastructure projects in the process of cluster development will be examined. Box 1 provides a show case for such a large scale project and its effects on regional cluster development in the energy sector of North Rhine-Westphalia.

Box 1 Centre for Fuel Cell Technology (ZBT GmbH)

The Centre for Fuel Cell Technology (ZBT GmbH) was founded in 2001 and received ERDF funding both for the initial infrastructure development and also for the technology investments and variable costs in its starting phase. For the first two years the university Duisburg-Essen provided provisional laboratory space for the centre. In fall 2003, the new building was completed and inaugurated.

The project

Duration of the project: 19.11.2001 – 31.12.2006; Total costs of the project amounted for € 11.4 million, including € 6.0 Mio. ERDF funding. Goal of the project is the establishment of the centre for fuel cell technology (Zentrum für BrennstoffzellenTechnik) ZBT GmbH in Duisburg. ZBT's focus of work is being a service provider in the field of fuel cell research and development in the region Ruhr district. It is to work as intermediaries between basic research and industry and to make available the appropriate fuel cell know-how for enterprises in North-Rhine/Westphalia. The project divides thereby into the two prime areas creation of the infrastructural conditions on the one hand and enterprise and fundamental research work on the other hand.

Effects

In 2006 the R&D personnel comprised 50 persons while third party projects with a total volume of € 2.0 million were acquired. Industry-science links are not only generated by joint projects. Since 2002, the association for the promotion of the Centre for Fuel Cell Technology represents more than 15 enterprises from the energy and mobility sector. Thus, institutionalised industry-science links were established which also led also to frequent joint projects. The Centre is in addition facilitating the working groups on fuel cell systems and stack design and assembling within the "competence network fuel cell and hydrogen technologies".

As can be seen, the Centre for Fuel Cell Technology brought forth several effects on the development of a cluster in the energy sector. Firstly the Centre did not only add to the regional knowledge base with new researchers and a new R&D infrastructure, it was in particular able to establish itself as a major node in the regional fuel cell network providing access to scientific knowledge and technical infrastructure to regional enterprises. Secondly the Centre actively developed industry-science co-operations within the region. Its active role in the "competence network fuel cell and hydrogen technologies" is strengthening its role as regional future cluster node.

While the Centre for Fuel Cell Technology was successful launched with ERDF funding in the programming period 2000 to 2006, other large scale pilot projects needed more time to develop: the "Blue Tower", a pilot plant for processing biomass into hydrogen gas was initially intended for constructing starting in 2004. However, owing to administrative problems it will now only be realised within the next few years. This pilot and demonstration plant was planned as an essential part of the Hydrogen Park in Herten – a development

concept for the Ewald brownfield situated in the vicinity of the town. The hydrogen park is intended to become, in its final stage, a major regional competence node for hydrogen technologies, encompassing not only the production of hydrogen, but also the development of final production of fuel cells. In its final stage, close cooperation with the Centre for Fuel Cell Technology (ZBT GmbH) is also foreseen.

Industry Science networks

Secondly the promotion of industry-science links and R&D activities in the energy sector will be assessed. Stimulation of such activities was brought on its way by the means of voluntary networks comprising regional firms, industry associations and R&D institutions. In particular the "competence network fuel cell and hydrogen technologies" proved particularly dynamic in the programming period from 2000 to 2006. The network was initiated in 2000 in order to develop regional industry-science co-operations. Based on an analysis of the regional networking potential by Agiplan (a regional consultant) the network was formed with thematic working groups as constituting elements. According to the beneficiaries interviewed these working groups functioned on the one hand as potential sources for R&D cooperation and business partners, on the other hand access to new technological knowledge was provided. In addition the network was also actively initiating co-operative projects in the technology field of fuel cells.
Two micro case studies will demonstrate the effects of the network and its working groups on the initiation of R&D projects with ERDF funding for the "competence network fuel cell and hydrogen technologies". Masterflex AG and Hydrogen GmbH have been both active member firms of the network being involved in working groups and thematic events. The R&D projects presented have been initiated and implemented in the framework of the competence network.

Box 2 - Masterflex AG – fuel cell development

Masterflex AG, founded in 1987 in Gelsenkirchen, is a medium sized firm (656 employees) producing polyurethane based plastics products. In recent years the firm has also specialised in the development and production of small scale fuel cells. The firm fuel cell branch is currently situated in the ZukunftsZentrum Herten (a local business park) but is intending to settle in the Hydrogen Park Herten as soon as space becomes available there. In the programming period Masterflex AG successfully applied for ERDF funding under Measure 2.8, for several projects.

Together with the regional office of the Fraunhofer Institute for Solar Energy Systems in Gelsenkirchen a small scale fuel cell was developed from 2002 to 2004. As a result, Masterflex has since been able to offer the 50 W PowerBox fuel cell to the market, providing electricity for mobile office systems.

Since 2001 the enterprise developed successfully PEM (Proton exchange Membrane) fuel cells for low range of performance. Here ERDF funded R&D-projects helped considerably in pre-commercial development. From 2004 to 2006 (in cooperation with the Hawk Bikes E&M GmbH in Berlin) an innovative pedal electric (Pedelec) transport device, the Cargobike, was developed in prototype. Parallel to pilot missions during the Soccer World cup in Germany 2006, Cargobike also received EU funding under the 6th framework programme: in January 2006 Masterflex AG was appointed to provide at least 40 Cargobike prototypes for pilot use as part of the HYCHAIN MINITRANS project. In 2008 Deutsche Telekom decided to buy 14 cargobikes for test use in their internal service unit in Berlin.

The technologies developed thus far have been seen by the firm as essential future investments. Currently fuel cells play no role in the economic performance of Masterflex AG as existing prototypes are just on the onset of successful commercialisation. .

Box 3 – Hydrogen GmbH – Midibus with fuel-cell propulsion system

Hydrogenics GmbH is the European subsidiary of Hydrogenics Corporation, a leading global developer of clean energy solutions. Hydrogenics is advancing the Hydrogen Economy by commercializing hydrogen and fuel cell products. Hydrogenise GmbH is responsible for fuel cell power products, with particular focus on fully packaged power modules and electric hybrid systems.

The project

Duration of the project within the programme period: 15.11.2004-30.06.2007. Total costs of the project amounted for € 1 million, including € 390,000 ERDF funding. The project was dealing with the development of a prototype of a small bus with a combined fuel cell and battery propulsion system. In particular the HyPM 10 fuel cell of Hydrogenics has been used and adopted for this purpose. The project has foreseen the development and testing of the prototype firstly in a laboratory environment and secondly under everyday lives conditions.

Effects

The project has led in combination with other research and development projects to employment effects: R&D personnel increased by two persons, leading to a stable level of R&D personnel in the enterprise. The development of the prototype led also to better position of Hydorgenics in new markets. In total 10 pieces of the midibus were sold after the end of the project. The success of the project .had also additional effects: The combined application of fuel cell and battery propulsion systems is now tested in other car models, leading to additional future product-market combinations.

The case of Masterflex AG demonstrates on the basis of anecdotic evidence that regional industry-science links were actively stimulated by the network. The case of Hydrogen GmbH and interviews with beneficiaries show that R&D projects with ERDF funding had a positive impact on employment of high skilled personnel and the competitive position of enterprises. Thus it can be concluded that the thematic bundling of funding under the umbrella of a specific technology field brought forth satisfactory steps into the direction of a new cluster. Nevertheless the anecdotal evidence and qualitative results also show that hydrogen and fuel cell technologies are in their initial stages of the technology life cycle; prototypes may require many more years before successful commercialisation becomes possible. A timeframe of only four to six years will never be enough "to change the world". Thus, new prospective technology strategies should not be judged by their success in terms of economic growth or employment generated, but rather by their ability to bring forth sustainable structures and institutionalised networks.

Measure 3.3 Technology Infrastructure

Measure 3.3 was designed as an intervention to be implemented in an already well developed field. In 2000 the Objective 2 region was already very well endowed with regional technology infrastructures, a funding of new projects in an open bottom-up process would have probably led to redundancies in the region. The strategy behind Measure 3.3 thus had to be more specific: the competence field (i.e. cluster) development approach of the overall strategy of the SPD was used as a guiding principle in the development of innovation infrastructure. New investments were primarily designed to support and host new technology based firms and foster industry-science co-operation. Synergies with Measure 2.1 (R&D projects) were intentional. Since emphasis was put on the creation of new infrastructures in terms of space, qualitative assessment on how Measure 3.3 has been able to support the competence field development approach in carried out below.

As a first step, a macroscopic qualitative analysis of the supporting role of technology infrastructure development for the respective competence fields is undertaken. Technology infrastructure development in

the programming period 2000 to 2006 mainly focussed on big projects. Large scale projects in the domain of technology infrastructure accounted for 57 % of the total investments (together with large scale qualification infrastructures, their share reached 88 % of the total project costs). Table 3.7 shows the large scale technology infrastructure projects for the programming period 2000-2006. In addition, the total investments, the location, and the type of infrastructure are indicated.

Table 3.7 - Large scale technology infrastructure projects funded within Measure 3.3

Project	total costs in million €	Location	Type	Competence field
Zentrum für Brennstoffzellentechnologie	3.9	Duisburg	R&D centre	Energy
FHG UMSICHT	16.3	Oberhausen	R&D centre	Energy
FHG IMS	27.2	Duisburg	R&D centre	Microtechnology
BioMedizin Zentrum Dortmund	21.6	Dortmund	Business and innovation centre	Medical Technology
Proteom-Kompetenzzentrum Dortmund	26.6	Dortmund	Business and innovation centre	Medical Technology
MST.factory	23.2	Dortmund	Business and innovation centre	Microtechnology
B1st-Software Factory	2.1	Dortmund	Business and innovation centre	ICT
Zukunftsenergie Technologie- und Gründerzentrum Lichtenau	3.6	Lichtenau	Business and innovation centre	Energy
Biomedizinzentrum Ruhr	15.3	Bochum	Business and innovation centre	Medical Technology
Kompetenzzentrum BioSecurity	15.8	Bönen	Business and innovation centre	Biotechnology
ZBZ – Zahnmedizinisch-Biowissenschaftliches Forschungs- und Entwicklungszentrum Witten GmbH	16.6	Witten	Business and innovation centre	Medical Technology
MST.factory Ausbau	26.8	Dortmund	Business and innovation centre	Microtechnology
FHG IMS Ausbau	8.7	Duisburg	R&D centre	Microtechnology

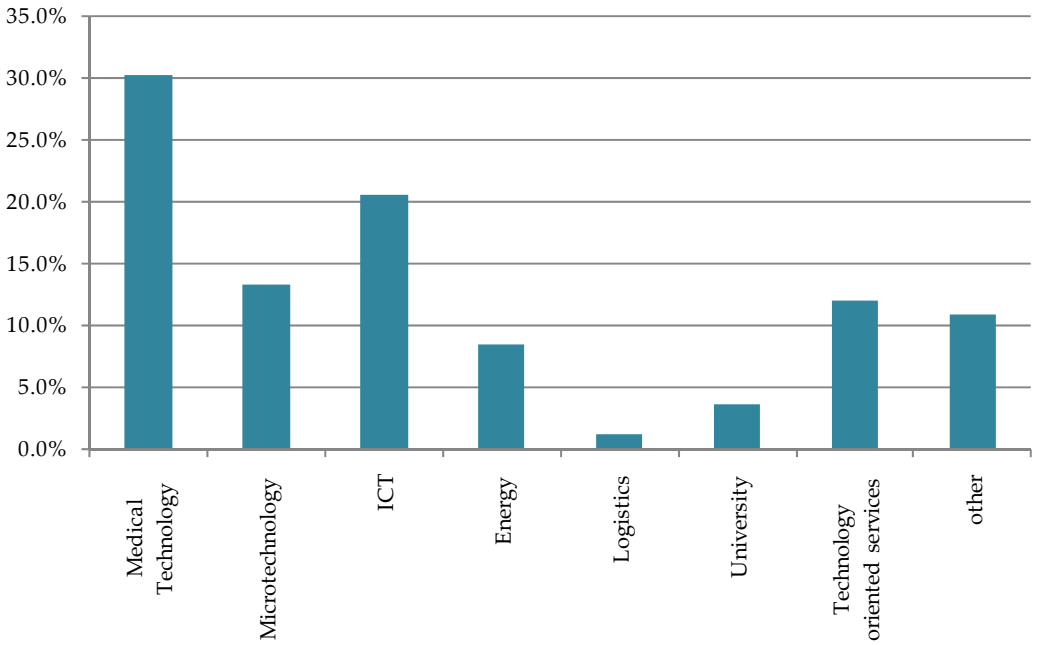
Source: Ministerium für Wirtschaft und Mittelstand, Energie und Verkehr des Landes Nordrhein-Westfalen 2001, 2002, 2003, 2004a, 2005, 2006, own data collection.

As can be seen, these large projects were all situated in the Ruhr area. They also reflect a selection of the competence fields identified as relevant and promising for North Rhine-Westphalia in the forefront of the programming period 2000 to 2006. The majority of large projects focused on the development of the technology fields of medical technology, micro-technology and energy technology. ICT was only present in one new infrastructure; one centre established specialises in bio- and food technology (i.e. bio security). R&D centres were mainly subject to upgrading activities: The Fraunhofer Institute of Microelectronic Circuits and Systems (IMS) was enlarged in two consecutive steps during the programming period (2002 and 2006), the Fraunhofer Institute for Environmental, Safety and Energy Technology (UMSICHT) was extended in 2002. For the Centre for Fuel Cell Technology (ZBT GmbH) funding complementary to Measure 2.8 was provided for the development of the centre building and technological infrastructure. Technology and science parks were established as complementary elements of the regional innovation infrastructure. Their alignment with specific competence fields was already discussed above. The lion's share of the new technology centres (i.e. BiomedizinZentrum Dortmund, Proteom-Kompetenzzentrum Dortmund, MST. Factory, B1st-Software Factory) was located in the TechnologieZentrum Dortmund.

Thus it may be concluded that at the level of big technology infrastructures Measure 3.3 proved sufficiently successful in providing support for competence field and cluster development. All the big projects fit into the landscape of future technology clusters. ERDF funding helped to fill the remaining gaps and provide the

prerequisites for future network and cluster development. The degree of networking attained so far can not be properly estimated at this level of analysis (a micro case study on this issue is done in example 3)
We now shift the analysis to the firm level. As 9 out of 13 of the large technology infrastructure projects funded were technology parks and incubators, the question arises, as to whether the mix of new technology based firms is in line with the envisaged competence field development. At the time of data collection for the case study (i.e. July 2009), in total 83 firms had settled in the big technology infrastructures that were funded in the programming period 2000 to 2006. Some centres were opened to the public only in 2008, thus the number of firms acquired is significantly below the estimated figures initially stated in the monitoring and progress reports. Figure 3.1 provides the relative shares of competence / technology fields for 2009.

Figure 3.1 - Firms in technology infrastructure by competence field, 2009



Source: own data collection and calculations

As can be seen, medical technology accounts for the largest share of firms with 30.1 % (25 firms). ICT holds the second place with 20.5 % (17 firms); micro technology with 13.3 % (11 firms) is only marginally more important than technology oriented business services, at 12 % (10 firms). 10.8 % of the firms do not belong to any of the competence fields of North Rhine-Westphalia. Nevertheless, it is noteworthy that some are still thematically close to the competence fields (i.e. media services, sector specific business consulting etc.). The three universities present in the infrastructures analysed are situated in the domain of medical sciences and information and communication technologies.
It may be concluded that to a certain degree, the envisaged competence field development is sufficiently reflected in the technological orientation of the firms hosted in the infrastructures. In particular, medical technology and ICT are strongly represented among the new technology based firms in the centres analysed. This can be interpreted as a positive result, since in the past, technology parks and incubators were often not able to adopt their intended technological orientation (Sternberg 1997).

In a final analytical step, the networking effects of the infrastructures for the development of future competence fields are examined. Example 3 provides a micro case study on the Bio-Medical-Centre Dortmund and its role in regional R&D and innovation networks.

Box 3 - BioMedizinZentrum Dortmund (Biomedical Centre Dortmund)

The BioMedizinZentrum Dortmund was initiated together with the Proteomics Competence Centre as a major node in the emerging competence field of health and medical technologies. The centre provides office space and laboratory infrastructure for new technology based firms in the medical technology sector. In the programming period the centre was built up in two steps: BMZ 1 with 3,000 m² office and laboratory space was inaugurated in 2002, BMZ 2 with 12,000 m² floor-space was completed in 2005. So far 18 new technology based firms with 270 employees have settled in the centre; their major fields of activity range from medical research to biotechnological applications. The BioMedizinZentrum Dortmund also hosts the institute for cardio-vascular research of the University Witten-Herdecke, an important element in regional R&D infrastructure in the competence field of health and medical technologies.

Besides its role as thematically centred technology park, the BioMedizinZentrum Dortmund also took an actively part in cooperative R&D activities in the emerging health and medical technology cluster during the programming period 2000 to 2006. In June 2006, the Lebenswissenschaftliche Innovationsplattform Dortmund (innovation platform for life sciences), was officially launched with ERDF funding and support from the federal state of North Rhine-Westphalia, receiving an amount of € 37 million. Funding was provided for networking activities and the conduct of joint R&D project. The platform comprises the Max Planck Institute of Molecular Physiology (MPI), with its centre for systems biology, the Ruhr-University Bochum, Dortmund University and the BioMedizinZentrumDortmund. The platform forms a regional network of applied R&D institutes and universities and is active in pre-competitive research and development between industry and science. R&D projects carried out within the network focus on the optimisation of methods in target retrieval for new drugs.

BioMedizinZentrum Dortmund is also member of the Bio Industry, a regional, networked service cluster of companies, research and training institutes, technology centres, biotechnological service providers and communal business development schemes in the Ruhr area. The focal points of Bio Industry's activities are bioprocess technology, microstructure technology, proteomics and bio-informatics.

As the discussion above shows, to some extent Measure 3.3 provided good support for the initial competence field development in the Objective 2 area: The remaining gaps in the already dense innovation infrastructure landscape were closed, while the new centres and incubators were thoroughly aligned with the prioritised technology fields in North Rhine-Westphalia. In particular new infrastructures were developed in the field of medical technology: This is a cluster (lead market health) that will be further developed in the programming period 2007 to 2013 (Ministerium für Wirtschaft und Mittelstand, Energie und Verkehr des Landes Nordrhein-Westfalen 2007). As example 3 shows, R&D networking effects are visible in the emerging competence field of medical technology, at least on the basis of anecdotic evidence. Since successful and sustainable cluster development requires decades, quantitative effects in terms of economic growth and employment cannot be shown. Several problems remain, however. While some of the centres developed fast and attracted firms straight after their opening, some other infrastructures did not do so well. Only the centres in the framework of the TechnologieZentrum Dortmund have been able to attract a significant number of firms so far. The surrounding real estate development (in the case of Dortmund the Phoenix West area) seems to have a strong influence on the performance of the centres.

3.2 Assessment of the effects on institutional capacity and policy learning

By the year 2000, regional programming for structural change already had a long tradition in North Rhine-Westphalia. Nevertheless, ERDF programming and funding brought additional benefits for the existing planning culture as the interviews with regional experts show.

Regional policy makers have become increasingly aware of ERDF funding since 1989. In the 1980s and the first half of the 1990s the Ruhr area received large amounts of regional and national funding. With the new need for development in East German Bundesländer, priorities shifted and degrees of financial freedom for regional policy shrank in North Rhine-Westphalia. Since 2000 ERDF funding has therefore been perceived as an increasingly important source of funding for fostering future structural change in the region. Since large scale ERDF funded projects have been extensively covered by local media (i.e. Newspapers as well as TV stations), public perception of the benefits of structural funds for regional restructuring processes is widespread. Nevertheless, it has to be noted that overarching umbrella initiatives such as the Dortmund project often outshone structural funds in public opinion.

The programming period 2000 to 2006 is conceived in retrospect by regional experts as a test-bed for new planning approaches. In 2000 structural funds allowed for the first time for a completely integrated planning approach, encompassing not only traditional domains of regional policy (i.e. spatial planning, infrastructure development,) but also environment, innovation, research and technology. As a result a coherent and well adjusted policy mix was developed forcing the regional ministries - being responsible for different policy domains - to co-operate actively in programme planning and implementation. The integrated planning approach was in particular beneficial for cross cutting issues such as the new competence field (i.e. cluster) approach. Necessary interventions could be addressed on a strategic level, thus moving well beyond standard regional (innovation) policy. For cluster development the time frame for planning of six to seven years also brought additional benefits. Regional funds, necessary for co-financing the ERDF contributions, had to be budgeted a long time in advance, thus providing more stable planning and implementing conditions. These conditions proved very important for beneficiaries, especially in the measures addressing infrastructure development, since many projects needed to be developed in several stages. Better adjustment in planning and development of policy mixes could be also reached between the involved ministries and regional administrational bodies below the level of the Bundesland. In addition a close cooperation with social partners on regional level could be achieved, ensuring the proper consideration of regional stakeholder's needs.

Experiences with the implementation of structural funds measures in the period 2000-2006 have led to policy learning effects in terms of developing new mixes of public interventions. Integrated projects proved to be a successful approach that finds now its continuation in the new programming period 2007 to 2013. Innovation policy measures have become more thematically focused, the competitive call based approach that has been successfully tested in the old programming period is now adopted more broadly in order to ensure a high quality of projects in the domain of innovation policy. The fostering of networks (i.e. promotion of industry-science co-operations and cluster development) is - based on positive experiences in the period 2000 to 2006 - continued intensively.

Structural funds planning did have, according to regional experts, a positive influence on regional evaluation culture in the sense of newly acquired competences and skills by regional policy actors. These are regarded as helpful for the tendering and negotiating of future evaluation projects. Nevertheless it should be noted that in retrospect the timing and setting of the mid-term evaluation is seen as being too early and too

broad to bring forth new insights. Policy has reacted to these experiences with a new focus on the evaluation of single measures within the new programming period. It is also noteworthy that interviews with beneficiaries showed a growing interest in evaluation results (i.e. mid-term evaluation) in the sphere of R&D institutions and intermediary organisations. Experiences in monitoring in the programming period 2000 to 2006 have also led to learning effects. The need of significant indicators that can be provided by firms is seen as paramount. Data on control groups to beneficiaries is also regarded as necessary in order to collect counterfactual evidence.

4. Conclusions: key findings and main message

Key findings

In North Rhine-Westphalia the challenges of structural change were a key issue for the ERDF programming strategy 2000 to 2006. At that time public interventions addressing structural change in the region already had a long tradition going back more than 30 years. In 2000 the Objective 2 region was facing particular complex challenges stemming from the regional specialisation and poorly developed industry science links. Public policy addressed these challenges with an innovative planning approach to be tested in the period 2000 to 2006.

The main research question of this case study was to which extent ERDF interventions have helped to increase sectoral competitiveness and to reinforce the innovation potential of regional enterprises in the eligible areas of North Rhine-Westphalia (Germany). In particular, did the ERDF support lead to improved industry science links in the eligible areas allowing them to exploit better the strong regional supply of scientific and technological knowledge? Due to the emphasis of the programming document, the case study focuses on two specific types of measures that have been supported: cluster development in the energy sector and the complementary development of the regional technology and training infrastructure.

The quantitative and qualitative assessment of the selected measures leads to the following conclusions:

1. The integrated planning approach of the ERDF programming period 2000 to 2006 proved essential for addressing the existing challenges of structural change

Poor innovation performance in the enterprise sector, the lack of regional industry science links in combination with a persistent industry based sectoral structure created an increased vulnerability of the region to exogenous market and technological shocks. Regional programming responded to these multidimensional challenges with a planning approach that was addressing promising regional technology fields. The concept of competence field (i.e. cluster) development was thus bundling different types of interventions under the umbrella of specific themes (i.e. energy, logistics, medical technology). In doing so, necessary actions (i.e. networking, infrastructure development) for the development of clusters could be funded accordingly.

2. The new concept of integrated planning brought forth an innovative approach towards projects

The structural funds planning period 2000 to 2006 opened up new ways for the design of public interventions. Integrated projects - comprising several dimensions of regional policy such as infrastructure development, training, and R&D funding - were successfully introduced by the regional government. These integrated projects also proved to be an adequate response to the multidimensional challenges of regional structural change in North Rhine-Westphalia. As the case of the "Zentrum für Brennstoffzellentechnologie" shows, funding under individual measures in Priority Axis 2 "innovation and competence development"

were in combination on the one hand resulting in an expansion of the regional R&D infrastructure and technological knowledge base, on the other hand industry-science links were successfully initiated.

3. Technology infrastructure development was also supportive to the integrative cluster approach

The funding of technology infrastructure projects was successfully coordinated by the setting of thematic priorities. New centres and incubators were thoroughly aligned with the prioritised technology fields in North Rhine-Westphalia. Thus emerging clusters could be supported by the means of new technology infrastructure. In particular new infrastructures were developed in the field of medical technology: This is a cluster (lead market health) that will be further developed in the programming period 2007 to 2013. New infrastructures had also positive effects on the creating of regional industry-science co-operations, addressing thus one of the key challenges of structural change.

Main Message

The cluster (or competence field) development approach of the overall programming strategy proved to be an adequate response to the complex and persistent challenges of structural change in the Ruhr area as described in the case study. It functioned thereby as a coordinating thematic umbrella of several measures trying to bring fourth synergies with an integrated policy mix. With the interventions in several measures the groundwork has been laid implicitly and explicitly for future clusters.
Although cluster development stranded the test as a new approach, development of new high technology sectors in the Ruhr area will need a lot of time. As the anecdotal evidence and qualitative results demonstrates, new emerging technologies like hydrogen and fuel cell technologies are in their initial stages of the technology life cycle; prototypes may require many more years before successful commercialisation becomes possible. A timeframe of only four to six years will never be enough "to change the world". Thus, new prospective technology (i.e. cluster based) strategies should not be judged by their success in terms of economic growth or employment generated, but rather by their ability to bring forth sustainable structures and institutionalised networks.

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5.2 List of persons interviewed

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- Matthias Fischer, Ministerium für Wirtschaft, Mittelstand und Energie des Landes Nordrhein-Westfalen, Referat 301, 24.07.2009

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