



Wuppertal Institut
für Klima, Umwelt, Energie
GmbH

Review of Long Term Visions and Strategies for a Sustainable Germany

German Country Brief to the LCS-R Network
Annual Meeting, Berlin 20-21 September 2010

Wuppertal Institute
Wuppertal, September 2010

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Country Brief

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Disclaimer

This paper represents solely the subjective view of its authors. It is no official document. We try to briefly sketch the German discussion and policy on long term sustainable strategies. In this context we would like to highlight the working paper status of this document. Although we try to provide a broad overview over the issue, due to the limited time for preparation we are not able to ensure that all relevant issues are covered to the extent they might deserve. We therefore invite all readers to provide us with their feedback on the document its contents and viewpoints in order to improve future versions of the paper.

Executive Summary

To date the term Low Carbon Society is yet not very common in the German discussion and policymaking for long term perspectives. However, particularly Chancellor Angela Merkel has introduced the term into the German debate and the most recent review of the German sustainability policy places strong emphasis on the development of a low carbon society.

The upcoming process of defining a German low carbon society strategy can build on a particularly strong basis as there is as well a long standing discussion and target setting on sustainable development and elaborated plans and strategies for the development of a low carbon energy system by 2050.

Currently the German Government is discussing a long term „Energy Concept“ which aims at reducing GHG emissions by 80% by 2050. This is to be achieved by a significant increase in energy productivity and a profound switch of the energy base to renewable energies. These targets are well based on a rather broad scientific discussion on the German future energy system and are among others to be supported by a new 2 bn € research program „Research for Sustainable Developments“ and a significant part of the research ministry’s „High Tech strategy“.

Further, many stakeholder groups and an increasing number of large cities as well as smaller municipalities are actively promoting a sustainable or 100% renewable development by the mid of the century.

1 Introduction

At the G8-Summit in Heiligendamm in 2007 the G8-leaders concluded to operationalise the ultimate goal of the UNFCCC by agreeing to try to cut global GHG emissions by at least 50% by 2050. This long term target has been reiterated and made more precise since then at several occasions e.g. at the G8 summit in L'Aquila and the COP in Copenhagen.

The results by the IPCC (2007) make it clear, that the target of cutting global emissions by more than half by the mid of the century means for industrialised countries a reduction of GHG emissions by 80 to 95% or to achieve a successful transition to a low carbon society by that date.

At the Major Economies Forum on Energy and Climate Change in L'Aquila, Italy, in September 2009 the leaders of those countries declared to prepare national "low carbon growth plans" (LCGP) The Council of the European Union welcomed the willingness of the participating countries to prepare LCGPs (Council of the European Union 2009, p. 2).

Unlike the United Kingdom or Japan¹, Germany does not have an official policy plan to promote LCS. However, since the European Union and Germany supported the idea of LCGPs, it can be expected that Germany will develop such strategies/plans soon.

The purpose of this country brief is to provide an overview on the German discussion on the relevant long term goals and strategies towards a low carbon society. The paper shows that – in spite of the fact that the term "Low Carbon Society" is not actively used in the German debate – there are several relevant discussion tracks that have started as early as the 1990ies and that have lead to a couple of targets relevant for a Low Carbon vision for Germany.

The first track of the German discussion is around the goal of transforming Germany into a sustainable society, which consists in many aspects of a low carbon society but has a scope that is significantly wider. This discussion has lead to the implementation of inter alia a national advisory council on sustainability (Nachhaltigkeitsrat) and to the decision of a set of sustainability targets for Germany. These include also targets relevant for a low carbon society such as "climate protection", "renewable energy", "mobility" and "conservation of natural resources".

The second relevant track is the discussion on the national climate protection and energy strategy – which stands clearly in the centre of a low carbon society. In this context as early as 1990 a parliamentary enquete commission has proposed a national CO₂ emission reduction target of -80% by 2050. This target has also been introduced into the national energy political discussion. This highly political discussion currently is currently focusing on the appropriate pathway to reduce

¹ e.g. Japanese "Action Plan for Achieving a Low Carbon Society"; the UK Low Carbon Transition Plan

GHG emissions from the energy sector by 85% by 2050 which is scheduled to result in a government long term strategy plan (Energiekonzept) by the end of September 2010.

In the following we give a brief overview of the existing long term sustainability visions, plans and strategies in Germany with a focus on important stakeholders and existing targets and scenarios. Further we sketch the current research landscape with regards to long term sustainability and energy visions.

2 Overview of existing long term sustainability visions, plans and strategies in Germany

The German discussion on sustainable futures is much broader than the concept of low carbon society, which emphasises, however a central aspect of a sustainable future. On the other hand a long term energy strategy is debated in Germany. A debate, which clearly covers the core (technical) issues of a low carbon society.

In the following sections we first show how the term LCS is used in Germany, which overall sustainability targets and plans exist and which plans and scenarios on a sustainable energy system are currently debated.

2.1 The term “LCS” and its use in German(y)

Although the term “low carbon society” (LCS) and its German translation “Kohlenstoffarme Gesellschaft” have not been used frequently in the German scientific and political discussion yet, its concept, strategies and goals are widely accepted. The terms “CO₂-free society” and “climate neutral society” are more common in German.

Most existing strategies for sustainable development, climate neutral development, future energy policy, research on climate protection and climate change, however, assume a low carbon society.

Within the German government the visions of a LCS are strongly supported by the Chancellor Angela Merkel and her chancellery. Not only internationally but also in the national context the government postulates strict CO₂ reduction policies with a long term perspective in order to reach its energy and climate policy goals in 2020 as well as 2050.

In 2009 Angela Merkel explicitly underlined that Germany wants to organize the transition toward a “kohlenstoffarme Gesellschaft” (LCS). At the same time she pointed out the need for a renewable energy era. These two aspects are closely linked in her strategy (Merkel 2009). In September 2010 the government is going to present a detailed outline of the future energy strategy of Germany. The public debate, however, mainly focuses on the issue of a limited extension of nuclear plants operational lifetimes.

Another strong supporter of the concept of LCS in Germany is the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. The ministry explicitly deals with the core issues of a LCS. Climate policy, emission trading, energy efficiency and renewable energies belong to its main foci. The ministry also serves as a central point for commissioning and conducting research on sustainable development (BMU 2010).

Moreover, the Federal Ministry of Economics and Technology supports the idea of a LCS. One of its core areas is energy policy with an emphasis on energy and climate. In the field of technology the ministry provides approximately half of the

funding for the High-Tech Strategy, a program which deals with different foci of LCS (BMW 2010).

The Ministry of Transport, Building and Urban Development also encourages to develop a complex LCS research strategy. For example, in the field of Transport and Mobility the ministry puts an emphasis on electric mobility as well as energy and climate change policy (BMVBS 2010).

2.2 Sustainability targets and their relation to the low carbon society

Reflecting the before mentioned discussion on the term, the recent Peer Review Report on Sustainable Development Policies in Germany used the term “low or zero carbon society” to describe the pathway of the country toward a sustainable future until 2050 (German Council for Sustainable Development 2009).

In accordance with the sustainability targets of the EU, there are several long term visions and aims to transform Germany into a low carbon and sustainable society.

In April 2002, the German government adopted a national sustainability strategy entitled “Perspectives for Germany”. It was based on the results of a consultation process with stakeholder groups and the proposals of the Council for Sustainable Development. Within four categories 21 targets substantiate the pathway toward a zero carbon society. The first category “justice for future generations” comprises the subdivisions: “conservation of natural resources”, “climate protection”, “renewable energy”, “land use”, “biodiversity”, “national debt”, “economic precaution for the future”, “innovation” and “education”. The second category “quality of life” embodies the subdivisions: “economic prosperity”, “mobility”, “cultivation”, “air quality”, “health and nutrition” and “delinquency”. The third category “social solidarity” includes the subdivisions: “employment”, “prospects for families”, “equal rights” as well as “integration”. “Development cooperation” and “opening up markets” form the fourth category “international responsibility”. Prominent quantitative sustainability targets are a doubling of energy productivity by 2020 as compared to 1990 and to minimize additional land use to 30 hectares a day by 2020². (Statistisches Bundesamt 2010). In 2009 the sustainable development policy of Germany was evaluated and reviewed by an international peer group.

In addition to the Governmental sustainability targets there are also visions from the civil society. The publication “Sustainable Germany” “Greening the North - A Post-Industrial Blueprint for Ecology and Equity” commissioned by different non governmental organizations and conducted by the Wuppertal Institute for Climate, Environment and Energy gained remarkable public and political

² Additional land use for settlement and transport increase the long-term costs of infrastructure in a society with drastically changing demographics; such land use also has damaging effects on nature protection, organic farming and the use of land as a carbon sink.

attention. Published in 1996 it was the first study in Germany that pointed out a detailed pathway to a sustainable Germany with ambitious goals and development concepts in different fields of society and economy including a target to reduce CO₂ emissions by 80% by 2050. An influential German magazine called it the "Green Bible for the 21st century" and the scientific discourse turned into a public debate (Zukunftsfähiges Deutschland o.J.).

12 years later, in 2008, a follow up study "Sustainable Germany in a globalized world" reviewed the development toward a sustainable development in Germany and presented general concepts of how to reach the goals in the future (Lexikon der Nachhaltigkeit o.J.a).

2.3 Long term climate protection targets

Achieving the ultimate goal of the UNFCCC is a major challenge of sustainable development. German policy debate therefore has given strong emphasis on climate policy and on the development and (international) promotion of binding quantitative mitigation targets.

In 1990 an Enquete Commission by the German parliament proposed different reduction targets of energy caused CO₂ emissions until 2005 and 2050 compared to 1987. Global emission reductions by 5% until 2005 and by 50% until 2050 were foreseen and translated into targets for Germany of - 25% by 2005 as well as -80% by 2050.

Although there are no legal targets in Germany, mid-term mitigation targets have been prominent on the political agenda since then. They have been implemented as self-commitments by the government or its supporting political parties in the respective coalition documents. Further more, the German government has internationally committed to these in the context of the EU and the Kyoto-protocol.

The coalition agreement of the current government stated an unilateral 40% GHG emission reduction target for 2020 and mentioned the international declaration of a long term GHG reduction target of at least minus 80% until 2050 (Die Bundesregierung 2009; p.26). Nevertheless, regarding the long term perspective, no strong political declaration has been made yet on the federal level. However, all scenarios which have been developed as a basis for the next energy concept assume a reduction of energy related GHG emissions by 85% by 2050 and the drafts of the energy concept aim at 80% GHG emission reduction and 60% renewable energies by 2050.

The current scenarios assume that these targets will be achieved mainly domestically. However they assume imports of renewable energy in the forms of biomasses and renewable electricity.

2.4 Long term sustainable energy scenarios for Germany

Energy policy has been a hotly debated topic in German politics for many years. Increasingly a broad consensus has emerged about the need to decarbonise the energy system. The most recent study (German Government 2010, published in August 2010) that has been commissioned by the federal government in order to design the future German energy concept aims for greenhouse gas emission reductions of 85% by 2050 over 1990 levels.

However, there is no consensus among the main stakeholders or among political parties on the right pathway towards decarbonisation. Efforts to expand the use of renewable energies receive rather broad support despite different views on how fast and to what extent renewables can replace conventional energy sources. However, the question of how much longer to rely on nuclear power plants is particularly contentious.

Energy scenarios have long been used by German policymakers as an instrument to support energy policy decision-making. Long term energy scenarios have been used for instance by several Enquête Commissions of the German Parliament: on “Protection of the Earth” I and II (1990 to 1998) and on “Sustainable Energy Supply” (2000 to 2002) as well as by Enquête Commissions of the parliaments of several “Bundesländer”, e.g. Bavaria and North Rhine-Westphalia (on the effects of significantly increasing prices for oil and natural gas imports on the economy and consumers). They have also been used in the context of the so called Energy Dialogue of the German Chancellor (2006 and 2007) and in the context of the German energy concept debate (2010).

The report from the 2002 Bundestag Enquête-Commission on “Sustainable Energy Supply” (German Parliament 2002) is a prominent example. Among other sustainability goals the Enquête-Commission aimed for a reduction of energy-related CO₂-emissions by 80% until 2050.

Within the past two years a number of long term scenario studies commissioned by different stakeholders (Federal Ministries, environmental NGOs and large electricity suppliers) tried to explore pathways on the possible future development of the German energy system. All of these scenarios explicitly aim for a considerable reduction in energy-related CO₂ emissions³ by 80% or more by the mid of the century. The following table summarizes the key characteristics of the mentioned studies' mitigation scenarios. It demonstrates that in spite of differences in details the general view on the future German energy system is quite similar. Continuous high final energy efficiency improvements of 2.2 to 2.8% annually combined with a significant expansion of renewable energy supply from the current 7% to 50% or more of TPES are regarded as prerequisite to a low

³ Some scenario studies (WWF 2009, Greenpeace 2009) also take account of GHG other than CO₂ and of non-energy related sources of CO₂.

carbon strategy⁴. Particularly electricity generation will be converted almost completely to renewable sources, dwarfing the other low carbon options like nuclear or fossils with CCS. However, the less optimistic scenario by the electricity utilities shows that there still is a considerable debate on how and if such a conversion is going to be feasible.

Figure: Key Indicators of Recent Low Carbon Energy Scenarios for Germany

Scenarios	Key indicators for 2050					
	-----Overall-----			-----Electricity generation ^a -----		
	Energy-related CO ₂ emissions (vs. 1990) ^b	Avg. annual energy efficiency improvement (2010-2050) ^c	Share of renewable energy in primary energy supply ^d	Share of renewable energy ^e	Share of nuclear energy	Share of electricity from fossil fuel plants equipped with CCS
Lead Scenario (BMU 2009)	- 80%	2.2%	50%	85%	0	0
Innovation Scenario without CCS (WWF 2009)	- 91%	2.8%	76%	97%	0	0
Innovation Scenario with CCS (WWF 2009)	- 90%	2.8%	59%	73%	0	22%
Plan B (Greenpeace 2009)	- 92%	n.s.	90%	100%	0	0
Scenario 3 (EnBW et al 2009)	- 68%	2.4%	36%	~ 50%	~ 12%	~ 3%
Energy Concept Scenarios (German Government 2010) ^f	- 85 %	~ 2.2%	~ 50%	77 – 81%	0 – 2.6%	8 – 9%

own data collection, sources as given in 1st column

The studies by BMU and Greenpeace both describe one policy scenario each. The study commissioned by WWF describes in detail two different policy scenarios which both achieve very similar CO₂ reductions by 2050. One of them assumes that carbon capture and sequestration (CCS) technologies are introduced in the electricity sector, while the other scenario assumes that these technologies are not introduced in this sector. The study for EnBW et al. contains two policy scenarios of which only the more ambitious one is documented here.

Footnotes: a: Not considering secondary electricity generation (i.e. electricity generation from storage plants). b: All CO₂ reductions are achieved domestically, meaning within Germany and without importing emission rights. c: Energy efficiency is defined here as GDP per unit of final energy demand. d: The given shares of renewables in primary energy production are calculated based on the common *physical energy content* method. e: Share includes import of electricity from renewable sources in some of the scenarios. Further (electricity-only) scenario studies have been released recently (SRU 2010, UBA 2010), describing an all-renewable electricity supply in

⁴ As a comparison, between 1990 and 2009 the average increase in energy productivity in Germany was 1.8%. However, throughout the 1990s, the value was considerably higher, at 2.4%.

Germany by 2050. f. The study contains 8 target scenarios describing different variants on how to achieve significant emission reductions. The given values represent average values or ranges of those scenarios.

The overview table of recent scenarios on the future of the German energy system shows that all of them assume a domestic reduction of energy-related CO₂ emissions of at least 80% by 2050 (vs. 1990 emissions). The only exception is Scenario 3 of “Energiezukunft 2050” (EnBW et al 2009), a study commissioned by the four big German utilities. This study concludes that the German government will not be able to reach its goal of reducing greenhouse gas emissions by at least 80% domestically by 2050. In contrast to this, the scenarios of the two studies commissioned by environmental NGOs (WWF 2009, Greenpeace 2009) aim at a reduction of energy-related CO₂ emissions of 90% or more.

All scenarios agree that significantly improving energy end use efficiency is possible and necessary to achieve major cuts in CO₂ emissions. As the third column shows, energy productivity (defined here as GDP per unit of final energy demand) increases on average by 2.2 to 2.8% annually in the scenarios. Apart from assumed changes in the economic structure this is almost exclusively achieved by efficiency improvements, while no or only minor behavioural changes are assumed.

While all scenarios envision a significant increase in the use of renewable energy sources, their share in 2050 in both, primary energy supply and electricity generation varies considerable between the studies. This is mainly due to different assumptions about (economically exploitable) renewable energy potentials in Germany in combination with varying assumptions about final energy demand. The scenario of the study commissioned by the conventional energy industry (EnBW et al 2009) is the only scenario in which even by 2050 renewable energy sources are not able to meet half of primary energy demand, despite assuming that ambitious climate policies are enacted. Instead, in the scenario some new nuclear power plants are built while CCS plants are not expected to play a big role in the German electricity system due to their high costs.

This scenario and one of the Energy Concept Scenarios (German Government 2010) are the only scenarios which assume nuclear power to still provide some electricity in Germany by 2050. All other scenario studies adhere to the nuclear phase-out plans as stipulated by the legislation currently (still) in effect and expect that nuclear power production will end by 2015 (Plan B) or between 2020 and 2025 (Lead Scenario and Innovation Scenarios). Some of the scenarios do not assume any use of CCS, as this technology is not seen as an economic and/or desirable option in the electricity system. Scenarios with a phase-out of nuclear energy and without CCS achieve a share of 85 to 100% of renewable energies in the electricity system by 2050. Looking at the two scenarios from the WWF study shows that when CCS is assumed to be an important mitigation option in electricity supply, the share of renewables in 2050 goes down from 97% to 73%. The difference is largely made up of coal power plants with CCS.

2.5 Core challenges of the transformation towards a LCS

The term “low carbon society”, emphasises the needs for fundamental changes beyond the introduction of new and efficient technologies only. It requires a change in life styles, as well as far-reaching changes in the framework conditions on national and international levels. A low-carbon society is achievable only if society, economy and political institutions integrate sustainable development (SD) into the core of decision-making. Although Germany has a good starting point for both – environmental awareness as well as climate policy – huge challenges are to be tackled. These are explained based on the findings of the recent “Peer Review of German Policies for Sustainable Development” which identified six core challenges for Germany. These are to establish adequate politics for sustainable development, to develop industrial and business

opportunities, to foster research and development for LCS, intensify participation, and improving finance and investment as well as education.

Politics for Sustainable Development

Fighting climate change ranks high on the German political agenda. It can be indicated that various German ministries, including the Federal Foreign Office, the Federal Ministry for the Environment, and the Federal Ministry of Labor and Social Affairs, have an increasing role in shaping economic policy in favour of a low carbon economy restructuring. As a result of the favourable conditions, in Germany, environmental and climate protection has become a major economic factor. The number of people in Germany working in the environmental sector is estimated at 1.8 million and the environmental industry has grown by an average of 10 percent each year since 2002. On the other hand, Germany is still a high-carbon society and efforts need to be stepped up considerably in order to meet the climate and sustainability targets set.

The 2008 Progress Report by the Federal Government and the Indicator Report by the German Federal Statistical Office (Statistisches Bundesamt 2010) highlight a number of trends, which counteract the sustainability goals set in 2002 (Bundesregierung 2002). Consequently the reports conclude that Germany should put more effort in the up-coming years on improving energy productivity and land use practices, in order to achieve the sustainability targets⁵.

Industrial and Business Opportunities in Green Technology

German environmental technology is highly successful in several green technology markets (Jacob et al., 2005). For many technologies the performance (in terms of revenue, market share and job creation) of German companies is outstanding (BMU, 2009). According to a market study research conducted by the BMU, the German production of environmentally friendly goods valued 69.5 billion Euros in 2007 and green tech constituted about 5 percent of German industrial production with an increasing trend. Between 2005 and 2007, the share of green tech in industrial production grew by 27 percent. (BMU and UBA 2009). However, the markets for green technologies in Germany can be expected to receive more competition from abroad. The German share of global export of environmental friendly products is 16.1%. Its most serious competitors are the United States with 14.9% and Japan with 9.2% of overall environmentally friendly exports (BMU and UBA 2009). Innovative technologies (fuel cells, solar thermal applications, Carbon Capture and Sequestration, etc.) and flexible-but-strict regulatory mechanisms are to be developed further, funded, and widely implemented to maintain the strong international demand for high-quality German

⁵ To achieve the target of doubling energy productivity by 2020 compared to 1990 would need an increase in energy productivity by 3.3% per year in spite of the current rate of 1.8% per year (1995 – 2010). To minimize the increase in land use is planned to 30 hectares a day by 2020. Between 2000 and 2008 land use decreased only marginally from 129 to 104 hectares per day.

technology. This requires fruitful cooperation between the business world, politicians, academics and civil society.

Research and Development for LCS

In terms of sustainability, one of the most important key issues is research and development (R&D). The government aims at an overall combined private and public investment in R&D of 3 percent of GDP in 2010. The actual level, however, remained at around 2.6% in 2008. An increasing share of the R&D is dedicated to green tech and sustainable development (see below.). Nevertheless, only a minor part of R&D is dedicated to LCS.

Participation

Achieving low carbon society vision will require a major coordinated effort, nationally and internationally. In the 2008 progress report, apparent strengthening of the so-called management approach to sustainability in the entire political process is praised. On the other hand, the report points out that sustainable development cannot be achieved by governmental policies only. It requires contributions from non-state actors—be it business, trade unions, civil society organisations or individual citizens. This holds true for both the development of the strategy, as well as for concrete action for implementation. The German strategy acknowledges the need for stronger action of non-state actors by explicitly including issue areas and setting goals that cannot be achieved without contributions from civil society (Zwirner and Berger 2008). What is needed is a clear vision on the role of the different actors. Effective participation that goes beyond a sheer dissemination of information requires transparency, motivation and capacities both on behalf of the government as well as by non-state actors.

Finance and Investment

At the same time Germany is part of a growing global competition for more efficient solutions for the energy and material use in sustainable development which makes it important to invest significantly more into these areas. The providers of financial services can supply capital to small and emerging sustainable businesses and industries and they can couple lending and financial services to certain sustainability criteria. This would act as an important driver for carbon-sensitive economic activity. One solution is to integrate carbon-related (and non-financial) criteria into risk analyses on a mandatory basis. Present efforts in this direction are voluntary, such as the Equator Principles, a set of 15 criteria applying ecological and social factors to all investments over 50 million Euros. Only two banks in Germany are currently signed up with Principles.

In addition to national efforts, Germany is or has been a member of several initiatives aimed at international cooperation on low-carbon issues, including the BRICS+G Sustainability and Growth Dialogue, the UN Global Compact and ICLEI-Local Governments for Sustainability. On the other hand partnerships for sustainable investment, production, consumption and development through low

carbon society on the international level should be further improved (German Council of Sustainable Development, 2009).

Education

Germany, as a high-tech nation, needs a professional workforce. This need will increase as climate change is addressed and Germany proceeds towards becoming a low carbon society. The vocational education system, which offers both an education in practical working skills as well as hi-tech knowledge, will need to adapt and take on a special role. There remains a significant gap between the number of training positions offered and demanded, even though the situation has been improved to some extent by the development of a dozen new or reformed training positions (*Ausbildungsberufe*) (Bildungsbericht 2006 and 2008).

There is also a large and apparently worsening gap between the economy's demand and the provision of many technology-oriented qualifications. In jobs related to steel, electronics and building—three key sectors for a low carbon future demand has continually increased, while the number of vocational education diplomas signed has decreased (Baethge et al. 2007).

The educational system performed poorly in the past particularly in regards to social segregation and immigration (Baethge et al. 2007; Bildungsbericht 2006). A number of challenges do exist: introducing bilingual education concepts, removing prejudices against immigrants by teachers and potential employers, improving economic and living situations, as well as providing stable residence permit status.

Reforming the vocational system alone, however, cannot solve this problem. Measures have to be taken much earlier and must include the whole educational chain, especially the (elementary and secondary) schools, address the economic situation of marginalized families and legal questions to counter the often precarious residence permit status. Furthermore, the academic education needs to be included into a holistic approach to prepare Germany for a new demand of qualifications in the field of LCS. Especially for the fields of R&D and innovation technological as well as natural science oriented degree programs would strengthen the long term orientation toward a LCS.

2.6 State and Municipal Low Carbon Plans and Strategies

Given the German federal constitution, action for the transformation towards a LCS is needed at the level of the Laender and municipalities as well as at national level. Lots of the responsibilities for important areas of sustainability action e.g. in the fields of energy and land consumption, education and training, or material economy rests with the Laender. Most of them have defined their climate and energy strategies within the framework of the national plans. However, long term visions such as SD and LCS have not been implemented

widely. However, the state of North-Rhine Westphalia is currently planning to establish a climate law with a binding GHG emission reduction path until 2050.

The situation is similar at the municipal level. Many of the municipalities have medium term climate strategies in place and their main concern is their limited capacity to realise their plans. However, recently the first cities started to develop their own long term strategies and thereby taking the issue of developing ideas to become Low Carbon Cities serious. Others – mainly smaller rural municipalities – have developed visions to become 100% renewable communities. To date this movement of municipalities and regions already covers more than 8% of the German territory.

Low carbon visions cities and metropolises are also under development. E.g. for Munich – third largest German city with a population of around three million Lechtenböhmer et al. (2009) developed on behalf of Siemens a scenario to reduce CO₂ emissions by 90% by 2058. More than 20 other cities are currently also conducting basic research on low carbon technologies for their cities in a framework of a project by the city of Düsseldorf, supported by the city of Hannover and the German Cities Association (Deutscher Städtetag).

3 Research toward long term targets for a Sustainable Low Carbon Society

As mentioned above, suitable research and development are of high importance for transformation towards a low carbon society. In the following the most relevant research activities by the Federal Government are sketched, as well as three high level advisory boards dealing with SD and LCS.

3.1 Federal Government Research

Research by the Federal Ministry for Education and Research (BMBF)

The German Federal Ministry for Education and Research conducts several programs that directly deal with research for sustainable development as well as low carbon society. In February 2010 the new framework program "Research for Sustainable Development" was announced. The BMBF will be providing funds of over 2 billion Euros for the development of sustainable innovations until 2015. In order to reach the target of cutting down the greenhouse gas emissions by 40% below the level of 1990 until the year 2020 additional research efforts need to be conducted.

Research for Sustainable Developments

With the new framework program "Research for Sustainable Developments", the BMBF plans to consistently implement the national Sustainability Strategy and the High-Tech Strategy in the area of climate protection, resource conservation and energy.

The new "Research Framework Program" will focus on the following central fields of action:

- Global responsibility - International networking
- Earth system and geo-technologies
- Climate and energy
- Sustainable economy and resources
- Social developments

Although the term is not mentioned, the new program strongly supports the vision, concept and strategies toward a LCS (BMBF 2010a).

As a part of the research framework program a comprehensive information platform on sustainability research www.fona.de has been established. It offers stakeholders, interested parties and the media the latest news, comprehensive background information on research activities and available services as well as opportunities for networking and establishing contacts with experts

Hightech-Strategy 2020

The second research program that provides relevant support for LCS research is the recently extended “Hightech-Strategy 2020”. Its focus lies on the fields of information and communication technologies, optical technologies, production technologies, material technologies, biotechnologies, nanotechnologies, microsystems technologies and innovative services. The areas of application cover automotive engineering, medical technology, mechanical engineering and logistics. By this program Federal Government wants to further strengthen Germany's position in the field of technology and seeks to promote transfer of research results into business applications (BMBF 2010b).

With the topics “climate and energy”, the second is “mobility” and the third one is “health and nutrition” three out of the five core areas of the “Hightech-Strategy 2020” are directly linked to sustainable development as well as LCS. They are also named as subdivisions within in the national sustainability strategy.

Research by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

Further relevant research for LCS is being conducted within the framework of the ressort research by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The consulting and research needs that are apparent from its total portfolio responsibilities are determined annually in an Environmental Research Plan (UFOPLAN). This plan is determined by the priorities and objectives of environmental policy (task oriented research) and provides basis for decision making and aids for the preparation, examination, development and implementation of environmental regulations and environmental concepts.

Within this framework a number of studies which form an important basis for the current research debate on LCS are conducted. These range from low carbon and high renewable energy scenarios for the German energy system over strategic research projects on material and resource efficiency to more concrete aspects like development of municipal climate protection strategies.

Research by the Federal Ministry of Economics and Technology

Another important ministry in the field of LCS research is the Federal Ministry of Economics and Technology (BMWi). One of the core areas of the ministry is the formulation of the German energy policy which is to be done in cooperation with the Ministry for the Environment, Nature Conservation and Nuclear Safety. The ministry puts an emphasis on the fields of energy and climate as well as the two exports initiatives for renewable energies and energy efficiency. In the area of technology policy the ministry supports the high-tech strategy for Germany (BMWi 2010).

Particularly relevant for LCS are two research programs on energy efficiency for cities and for buildings. Their aim is the energetic optimisation of individual buildings, and to support comprehensive approaches to urban areas as well as to

local and district heating networks. Energy efficiency and low carbon developments can be improved significantly via intelligent use and networking of innovative technologies with research and pilot projects. The ministry therefore promotes research on energy efficient cities (EnEff:Stadt) and energy efficient heating and cooling networks (EnEff:Wärme) (EnEff:Stadt und EnEff:Wärme o.J.).

3.2 Advisory boards on LCS and SD

The German Federal Government has installed several advisory boards whose task is to monitor recent trends and provide the government with strategic insight from experts. They are preparing regular reports comprising progresses and recommendations on a regular basis. Three of them are particularly dealing with the LCS and SD strategies as part of their scope. Their tasks deal not only with energy but also the environment as well as related social aspects.

Council for Sustainable Development (Rat für Nachhaltige Entwicklung) (www.nachhaltigkeitsrat.de): the functions of the Council are the development of contributions to the implementation of national sustainable development strategy, the designation of specific areas of action and projects such as climate, energy, demography, economy, consumption, mobility and environment and to make sustainability an important public concern.

German Advisory Council on Global Change (WBGU) (www.wbgu.de): The Council's principal tasks are to analyse global environment and development problems and report on these, review and evaluate national and international research in the field of global change, provide early warning of new issue areas, identify gaps in research and to initiate new research, monitor and assess national and international policies for the achievement of sustainable development, elaborate recommendations for action and research and raise public awareness and heighten the media profile of global change issues.

Germany Advisory Council on the Environment (SRU) (www.umweltrat.de): Mission of the council is to describe and assess environmental conditions, problems, and political trends and to point out solutions and preventive measures. As set out in its mandate, the SRU submits an Environmental Report to the German federal government every four years. The report describes and assesses environmental policy developments and provides in-depth analyses of selected topics.

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