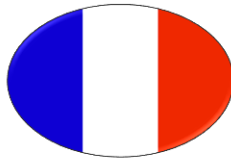


APPENDIX C

POLICIES FOR LOW-CARBON INNOVATION AND DEPLOYMENT IN DENMARK, FRANCE, GERMANY, THE NETHERLANDS AND THE UNITED KINGDOM

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EXPLANATORY NOTE

Innovation challenges for low-carbon technologies are linked to the broader challenges of climate change and to the EU's energy policy targets: sustainability, security of supply and competitiveness. The EU Member States' policies are subsequently harmonised to the EU common policy and targets, preserving a strong national pattern according to the local natural conditions and constraints, to the research, innovation and industrial tradition, to the particularities and strengths of the economy. Taking into consideration the above, this study focuses on the national policy measures in convergence with the main EU strategies and targets, without insisting on the implementation of the EU legislation.

Low-carbon technology is a relatively new field, arising from more complex needs than the product functionalities for a given process or service. The old free-market concept saying that a good idea will naturally find a market is no longer valid in the context of low-carbon innovation. Moreover, the classic linear model is no longer satisfactory when faced with the complex process of innovation, and related policy fails to provide sufficient support to the innovation flow from the research stage to development and commercialisation. The innovation process is based on a complex communication between the users and all the innovation stages. Fostering the market penetration of new ideas implies specific and targeted public support on both the supply and demand side, including research and development (R&D) and market policies as well as properly tailored financing for all innovation levels. In particular, low-carbon innovation must be included in wider strategies for sustainable development, climate change, transition to a low-carbon economy and market transformation. The main scope of this study is to reveal the low-carbon innovation chain with a particular view on the so-called 'valley of death' – the transition from basic research ideas to market viable products. Taking into consideration the above, this study does not insist on the R&D supply side, considering only the main strategies and plans setting the stage for the transition to a low-carbon economy and driving or influencing the innovation diffusion at the early market stage.

SMEs represent around 99.8 per cent of EU-27 enterprises in the non-financial business economy, employing two thirds of the workforce and generating 58 per cent of total value added¹. Despite their importance, 'the SME financial gap' is well known: SMEs have difficulty attracting bank lending or venture capital due to a higher investment risk and a lower return than bigger companies. On the other hand, the SME sector contributes more than 40 per cent to EU-27 research and innovation, and their role in developing and deploying low-carbon technology can be significantly increased by offering specific support in all stages of innovation. The SMEs support for low-carbon innovation is described in each country profile, and specific instruments are explained. In addition, overall supply-side and demand-side policies may include SMEs in their target group, though this is not always explicit.

Creating competition is one of the major drivers of innovation and an important condition for sustainable technological change in the energy sector. Low-carbon technology is difficult to implement as long as it has to compete with cheaper energy from fossil fuels and nuclear. Therefore, regulatory and market mechanisms are a determining factor in facilitating low-carbon technology market diffusion, strongly influencing at the same time the innovation policy at the supply side of the chain. The demand side policies described in this study are those that create better market conditions and better financing for low-carbon technologies. Public procurement was also considered to be an important factor in improving the market penetration of 'green' low-carbon technologies.

¹ SMEs were the main drivers of economic growth between 2004 and 2006 - Issue number 71/2009, Statistics in focus, Eurostat

This study assesses the low-carbon innovation and deployment in five selected EU Member States: Denmark, France, Germany, the Netherlands and the United Kingdom. Despite the fact that these countries are among the leaders of innovation in the EU, our analysis reveals significant differences between their policy frameworks, innovation structures and market penetration levels for low carbon technologies.

1. DENMARK

1.1. LOW-CARBON INNOVATION CONTEXT

Implementing the United Nations Framework Convention on Climate Change (UNFCCC) Kyoto Protocol and the European Council's Decision on burden sharing², Denmark has a target of a 21 per cent reduction in greenhouse gas (GHG) emissions by 2012, but only a 7.9 per cent reduction was reached by 2008. Being well behind target, Denmark must intensify carbon dioxide (CO₂) reduction efforts; however, Danish policy is deeply oriented on environmental issues from years ago.

Denmark had been self sufficient in energy production, but the oil and gas reserves from the North Sea have started to decrease. Denmark will therefore lose its status of net exporter of energy and will become a net importer of oil and gas. At the moment, Denmark is importing only solid fuels, but coal consumption is decreasing very fast and is being replaced by gas and renewable energy (a 19 per cent decrease in 2007 compared to 2006 levels)³. Denmark has a mandatory target of a 30 per cent share of renewable energy⁴ in gross energy consumption by 2020 (the renewable share was 19 per cent in 2009⁵) and an indicative target of a 29 per cent renewable share in the gross final consumption of electricity by 2010⁶. Concerning the last target, Denmark already reached a 26.7 per cent share of renewable electricity by 2008, of which wind power represents 18.3 per cent.

Denmark has an R&D intensity of 2.55 (R&D expenditure as a percentage of GDP) – well above the EU average (1.85). Around 65 per cent of these funds went to the private sector research, 7 per cent to public research and 27 per cent to higher education research. The share of public expenditure on environment and energy R&D is 1.9 per cent and 3 per cent respectively⁷. Denmark has a strong education and financial support for research and innovation and is among the innovation leaders in EU according to the last European Innovation Scoreboard⁷. However, the situation was considered to be stagnant, without significant progress from the last evaluation. Denmark is among the top ten world innovation leaders, being particularly strong in wind technology with a significant number of patents. Danish research and innovation also claims a top ten position for patents in solar photovoltaics and concentrators, biomass and clean coal technology⁸.

According to a WWF report, Denmark is the world leader in terms of clean technology sales weighted by GDP⁹. Danish exports of energy technology more than tripled from 1998 to 2008 and today make up around 11 per cent of total Danish goods exports¹⁰. Strong positions may be found in technology areas such

²European Council Decision of 25 April 2002 concerning the approval, on behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments

³Renewable Energy Policy Review. Denmark. Factsheet elaborated in the framework of the EU project: RES 2020: Monitoring and Evaluation of the RES Directives implementation in EU27 and policy recommendations to 2020. EREC 2009

⁴DIRECTIVE 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

⁵Danish Energy Policy 1970-2010 Vision: 100 per cent independence of fossil fuels. Danish Energy Agency

⁶Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market

⁷European innovation Scoreboard (EIS) 2009, Comparative analysis of innovation performance, Pro INNO Europe and European Commission Enterprise and Industry, ISBN 978-92-79-14222-2, 2010

⁸Who Owns Our Low Carbon Future? Intellectual Property and Energy Technologies. A Chatham House Report, September 2009

⁹Clean Economy, Living Planet - Building Strong Clean Energy Technology Industries. Roland Berger Strategy Consultants, study commissioned by WWF Netherlands, November 2009

¹⁰Danish Energy Policy 1970-2010 Vision: 100 per cent independence of fossil fuels. Danish Energy Agency

as wind energy, building insulation, biomass including burning of biomass in power stations and development of methods to produce second generation bioethanol. Other fields to be mentioned are fuel cells and components to be used in relation to heating and cooling.

Due to a strong national policy dating from the 1980s, Denmark registered a significant growth of renewable energy share in the energy consumption, being a global leader of installed wind energy per capita and having a very well developed wind industry (serving around one third of the global market)¹¹. The wind power installed capacity registered 3.46 GW in 2009¹², representing around 20 per cent of the country's energy consumption.

In 2007, biomass was responsible for 8.4 per cent of total gross electricity production in 2007 and supplied some 32 per cent of total gross production for district heating. In Denmark, biomass is largely used at power stations and for the development of smaller biomass-based co-generation of heat and electricity.

Over the last decades, Denmark has decoupled economic growth from energy consumption, increasing the use of renewable energy and promoting energy efficiency and district heating. Since 1990, energy efficiency has improved significantly in Denmark and primary energy intensity has declined by 26.3 per cent from 1990 to 2007¹³.

1.2. STRATEGIES AND SUPPLY-SIDE POLICY FOR LOW-CARBON INNOVATION

Low-carbon innovation and deployment was among the main topics of the Danish policy over the last two to three decades. A major strength of Danish policy is that both the ruling and opposition parties signed agreements on strategic, long-term political documents. This gives stability to political decision making, and predictability and sustainability to both research and innovation and the business environment.

In 2007, the Danish Government released a policy statement, **A Visionary Danish Energy Policy 2025**, which contains proposals for the cost-effective fulfilment of overall energy policy objectives for security of supply, environmental impact and competitiveness. The initiatives in the proposal combine political regulation and market mechanisms. The proposal is founded on the government's forward-looking vision for Denmark being entirely independent of fossil fuels – coal, oil and natural gas. With a view to realising its vision, the government set the following targets prior to 2025:

- A minimum 15 per cent reduction in the use of fossil fuels compared with 2006. The energy saving initiative will be increased to 1.25 per cent annually.
- The share of renewable energy must be increased to at least 30 per cent of energy consumption by 2025.
- A doubling of publicly funded research and development into, and demonstration of, energy technology to DKK 1 billion annually from 2010 onwards.

In order to achieve these targets the government proposed a number of new energy saving and renewable energy initiatives along with initiatives aimed at new and more efficient energy technologies. Additionally, the statement provided that the proposed targets and means would be reappraised every four years, in

11 Danish Energy Policy 1970-2010 Vision: 100 per cent independence of fossil fuels. Danish Energy Agency

12 EWEA, wind power and wind turbine database http://www.thewindpower.net/statistics_countries.php data from 2009

13 Energy Efficiency trends, Policies & Measures in DENMARK (1990-2007). Monitoring of Energy Efficiency in EU 27, Norway and Croatia (ODYSSEE-MURE), Danish Energy Agency, September 2009

2015 an interim assessment would be made of the extent to which targets have been met, and the efficiency of the initiatives and measures taken would be appraised.

In 2008 the government parties entered into a comprehensive **energy agreement** with the opposition on the future energy policy. The framework agreement aims to lower Denmark's dependence on fossil fuels (coal, oil and gas) via energy savings and renewable energy targets. The effort to save energy is being considerably ramped up: the new agreement commits Denmark to cut its energy consumption by 2 per cent by 2011 (and 4 per cent by 2020), compared with 2006 levels. For new residential buildings there is an overall target of a 75 per cent reduction in energy consumption (in three steps) by 2020. For the renewable energy share of gross energy consumption a target of 20 per cent by 2011 was established, as well as supportive schemes for wind energy, biomass, biogas, heat-pumps, small renewable systems and district cooling. Hydrogen vehicles are to be tax-free and the same applies to electric vehicles provisionally until 2012, and a pool of 35 million DKK is being set aside for research on electric vehicles. Measures to fulfil the targets are proposed and among them are increased savings obligations for the energy companies, subsidies, tax exemptions and incentives for renewables and biofuels, promotion campaigns and additional funds for research and innovation programmes¹⁴.

The 2009 **Promotion of Renewable Energy Act**, contains four new schemes to promote the development of wind turbines on land: loss of value to real property due to the erection of wind turbines, local citizens' option to purchase wind turbine shares, a green scheme to enhance local scenic and recreational values and a guarantee fund to support the financing of preliminary investigations. The Act also provides detailed feed-in premium tariffs for wind, biomass, biogas and other renewable-sourced electricity production. In addition, a special fund to promote the development of small-scale, grid-connected renewable energy plants was established, to be managed by Energinet.dk. The fund will amount to DKK 25 million per year for four years. Finally, the Act also clarifies how market prices for different prices will be determined by Energinet.dk, and imposes reporting obligations on grid companies¹⁵.

Research and development on climate issues and on low-carbon technology is considered to be of utmost importance by the Danish Government. In order to achieve the long term objectives to transform Denmark into a green and sustainable society, the Danish Government has increased public budgets for energy R&D to around 1 billion DKK yearly in 2010 (twice as much as in 2005/2006). Among the main instruments for stimulating low-carbon research and innovation are funding schemes, public-private partnerships for strategic technology areas and international cooperation in clean energy RD&D.

Energy R&D and innovation is supported by the Strategic Research Council and by the Advanced Technology Foundation and is mainly driven by the **Energy Technological Development and Demonstration Program (EUDP)**¹⁶. The EUDP focuses on bringing together innovative companies, knowledge centres, energy companies, venture companies and other potential investors in public-private project consortia. An important part of EUDP's brief is to showcase newly developed energy technologies. The government's priorities for climate and energy mean that significant resources in the 2009 budget are devoted to energy and climate research. This means that:

¹⁴ http://www.ens.dk/en-US/policy/danish-climate-and-energy-policy/Documents/Energy_per_cent20Policy_per_cent20Agreement_per_cent2021_per_cent20Feb_per_cent2008_final.pdf

¹⁵ Act no. 1392 of 27 December 2008: http://www.ens.dk/en-US/Info/Legislation/Energy_Supply/Documents/Promotion_per_cent20of_per_cent20Renewable_per_cent20Energy_per_cent20Act_per_cent20- per_cent20extract.pdf

¹⁶ Ministry of Climate and Technology: <http://www.kemin.dk/en-US/climateandenergypolicy/researchanddevelopment/Sider/researchanddevelopment.aspx>

- In 2009 DKK 750 million is to be earmarked for energy research and development.
- This amount rises to at least DKK 1 billion in 2010.
- DKK 43 million must be used on climate research and research into climate change adaptation in 2009.

According to the **Act on the Research Advisory System**, The Danish Council for Strategic Research supports research in politically defined areas and one of the established Programme Committees is dealing with Sustainable Energy and Environment. In 2009-2010 the focus is on research themes such as: future energy systems; competitive, environmental technology and the future climate; and adaptation to climate change¹⁷.

To establish a long-term strategy for environmental policy in the agricultural industry, the Danish Government and the other parliamentary political parties signed the **Green Growth Agreement**. The objective of the strategy is to combine the protection of the environment and nature with modern and competitive agricultural production. Several biogas production initiatives are envisaged as part of the Green Growth strategy for agriculture and a starter fund is to be established to support biogas plant production. Increased investment in green technologies also forms part of the Green Growth strategy. This will see the creation of a grant fund of DKK 145 million annually, dedicated to green technology development¹⁸.

In 2009 the Danish Government introduced the **Sustainable transport – Better infrastructure** strategy with the primary objective of reducing transport associated CO₂ emissions. This strategy supports the introduction of electric vehicles by introducing a tax exemption up until 2012 and subsequent reduced taxes in 2012-2015.

1.3. SME'S SUPPORT AND TECHNOLOGY TRANSFER

In 2006 the Danish Government decided to strengthen private-public collaboration between government, companies, knowledge institutions and venture capital. The initiative aims to establish partnerships for innovation, where companies and research institutions may work together on common visions and strategies to develop and demonstrate new technologies taking into account market and export potentials.

The objective is to accelerate innovation of technologies that may help in reducing environmental problems. Participants in partnerships should identify opportunities and needs and agree on common goals and financing of development projects. The activities must be concrete, mutually binding and implementable and could include:

- Joint development of demonstration projects
- Collaboration on strategic actions abroad
- Targeting education
- Improving the public guidelines in the specific field
- Coordination of knowledge building within the existing companies and organisations
- New forms of knowledge sharing between public knowledge institutions and private companies

¹⁷ The Danish Agency for Science, Technology and Innovation: <http://en.fi.dk/>

¹⁸ Agreement on Green Growth, 16 June 2009: http://www.mim.dk/NR/rdonlyres/54887891-D450-4CD7-B823-CD5B12C6867A/0/DanishAgreementonGreenGrowth_300909.pdf

In the energy field the following partnerships are established:

- The Megawind Partnership
- Danish Partnership for Hydrogen and Fuel Cells
- Danish Partnership for bio fuels
- Partnership to lower energy consumption in buildings

The Danish National Advanced Technology Foundation has the general objective of enhancing growth and strengthening employment by supporting strategic and advanced technological priorities within the fields of research and innovation. The foundation shall make a special effort to promote research and innovation in SMEs. Support is not restricted to energy technologies but so far between 20-30 per cent of the budgets have been allocated to energy technology projects. It also includes R&D projects in the energy field.¹⁹

In 2009 the government released **the Danish Business Strategy on Climate Change**²⁰, proposing that a total of 600 million DKK of the globalisation funds should be earmarked for implementing initiatives in the strategy from 2010 to 2012. Among the main initiatives, the strategy: strengthens the development of new climate-related solutions and encourages innovation; sets a programme for the provision of start-up packages to the clean-tech entrepreneurs; provides new guarantees and loans for climate-related export projects; and establishes an alliance of Danish players in the field of climate-related solutions to continue the work of Climate Consortium Denmark. Under the strategy several clean-tech partnerships are established to provide new business opportunities and offer specialised advisory services like scaling-up and internationalisation, as well as access to highly specific technical knowledge. As part of the programme for market maturation and the commercialisation of green solutions, companies receive extensive advisory support from business models to market studies and potential financing from the national programmes and funds.

The Danish Government set up the Climate Consortium Denmark, a government-business joint-venture which aims to promote Danish industry and business on the domestic market and in third countries²¹.

1.4. DEMAND-SIDE POLICY FOR LOW-CARBON INNOVATION

Denmark has a very well developed market for low-carbon technologies, offering targeted supporting programmes and customised market instruments which favour the deployment of energy-efficient and renewable technologies and processes. The following table summarises the main low-carbon technologies market deployment policies in Denmark²².

Market policy for low-carbon technology	Feed-in tariff/premium	Subsidies / grants/rebates	Investments/tax credits	Energy/sales/excise taxes or VAT reduction	Tradable certificates	Public investments, loans or financing	Public procurement
	x	x	x	x	x	x	x

¹⁹ Danish National Advanced Technology Foundation: <http://www.hoejteknologifonden.dk/?id=29>

²⁰ <http://www.denmark.dk/NR/rdonlyres/C14F421F-F33E-4EB4-BF9E-786086019C3F/0/SingleTheDanishBusinessStrtegyonClimateChange.pdf>

²¹ <http://www.kemin.dk/en-US/climateandenergypolicy/dkpolicy/business/Sider/Business.aspx>

²² Table based on: Renewable 2010. Global status report (REN21)

The Danish Electricity Trust issued **Purchasing Guidelines** for public and private sector organisations and companies to purchase energy-efficient equipment and appliances. All municipal and government institutions must purchase energy efficient equipment based on the Purchasing Guidelines. The Trust has also developed online tools to help purchasers make energy-efficient decisions.

The Climate and Energy Ministry signed voluntary agreements with Danish municipalities (LGDK) for implementing energy savings measures and consequently reducing energy usage. The agreement with LGDK will run until 2012, when a joint assessment of the initiative will be conducted. Through the EcoCities initiative, several municipalities already commit to more ambitious targets in terms of reducing CO2 emissions and energy usage and increasing the contribution of clean energy technologies²³.

Denmark's 2009 **Promotion of Renewable Energy Act** establishes detailed feed-in tariffs and premiums for wind power, biogas, biomass and other sources of renewable energy. The feed-in premium schemes are tailored for onshore and offshore wind power as well as for industry and private owners of small wind turbines. Feed-in tariffs for electricity produced by wind power producers that have scrapping certificates are also updated in the Promotion of Renewable Energy Act (see separate entry). Biogas and biomass electricity production, energy production from biomass and biomass plants have also specific feed-in tariffs. For solar, wave energy, hydropower and other renewable energy plants (except for biomass and biogas), separate tariff provisions apply and last for 10-20 years, depending on the date of grid connection²⁴.

Since January 2005, biofuels are exempt from the CO2 tax imposed on the use of ordinary petrol and diesel for transport. The government decided in 2006 to significantly boost efforts to promote the use of second generation biofuel technologies by allocating an additional DKK 200 million for the co-financing of large-scale private development programmes. Altogether, these additional private and public development interventions are expected to total significantly more than DKK 200 million. The 2008 grants amounted to DKK 222 million, mainly addressing the second generation bioethanol technologies. The purpose of this initiative is to establish large-scale research and demonstration plants for second generation biofuels in Denmark by 2010²⁵.

In Denmark, the grid and distribution companies contribute to the realisation of energy savings through a **trading system scheme (White Certificates)**. As a result of the comprehensive saving targets in the energy agreement from 2008, the saving target of grid and distribution companies will be increased by 85 per cent by 2010. The Danish Energy Agency is negotiating an agreement with the grid and distribution companies, specifying the energy saving targets for each energy sector and rules for calculation, documentation etc of the savings²⁶.

Denmark has the highest level of environmental taxation in the EU. In 2008 environmental taxes counted for 5.7 per cent of GDP, the highest proportion in the EU by a wide margin²⁷. This reflects its comprehensive and ambitious energy tax system, in which all energy projects are subject to both energy and CO2 tax, as well as a wide range of other taxes levied on environmentally harmful substances and products. The level of environmental taxation is further increased in the context of the tax reforms to be phased in from 2010

²³ <http://www.kemin.dk/en-US/climateandenergypolicy/dkpolicy/municipality/Sider/municipalities.aspx>

²⁴ Act no. 1392 of 27 December 2008: http://www.ens.dk/en-US/Info/Legislation/Energy_Supply/Documents/Promotion_per_cent20of_per_cent20Renewable_per_cent20Energy_per_cent20Act_per_cent20- per_cent20extract.pdf

²⁵ Renewable Energy Policy Review. Denmark. Factsheet elaborated in the framework of the EU project: RES 2020: Monitoring and Evaluation of the RES Directives implementation in EU27 and policy recommendations to 2020. EREC 2009

²⁶ Energy Efficiency trends, Policies & Measures in DENMARK (1990-2007). Monitoring of Energy Efficiency in EU 27, Norway and Croatia (ODYSSEE-MURE), Danish Energy Agency, September 2009

²⁷ Taxation trends in the European Union. Data for the EU Member States, Iceland and Norway. 2010 edition. Eurostat

to 2019. The reform is partly financed by higher energy, transport and environmental taxes to support the energy and climate policy objectives of the government. These increases are partly compensated by giving a 'green cheque' of DKK 1300 (around €175) to everybody above 18 years and DKK 300 per child for up to two children. The green cheque is nominally fixed and is rapidly phased out for income above DKK 360000 (€48300).

2. FRANCE

2.1. LOW-CARBON INNOVATION CONTEXT

Under the Kyoto Protocol commitments and the European Council's Decision on burden sharing, France has to preserve its baseline year GHG emissions by 2012. In 2008, France achieved a 6.5 per cent emission reduction (compared to the baseline)²⁸.

Despite the fact that France has reduced the contribution of coal (4 per cent in 2007, from 7 per cent in 1990) and oil (44 per cent in 2007, from 51 per cent in 1990)²⁹ in the energy mix, France is still significantly dependent on fossil fuel imports. France has a particularly strong nuclear sector, accounting for around 77 per cent of electricity production, and this can be considered as a barrier for renewable technology deployment. As an argument, the renewable share in gross electricity consumption was 14.4 per cent in 2009³⁰, below 1997 levels³¹ and well below the 21 per cent share by 2010 as required by the indicative target from the EU renewable electricity Directive.

Implementing the renewable energy Directive³², France has a mandatory target of 23 per cent share of renewables in the gross energy final consumption by 2020. In 2009, the renewable energy share in gross final consumption was at around 12.4 per cent, but in the context of a 5 per cent reduction in energy consumption that can be attributed to the economical downturn. However, it is worth noting that renewable energy production was the only sector which increased in 2009, despite a decrease in hydropower generation.

France has a strong education, R&D and industrial culture, but according to the last European Innovation Scoreboard³³ is only in the second group of EU innovators (the innovation followers). In 2007, according to Eurostat³⁴, France has an R&D intensity of 2.08 (R&D expenditure as a percentage of GDP), above the EU average (1.85). Around 63 per cent of these funds went to private sector research, 17 per cent to public research and 19 per cent to higher education research. The share of the public expenditure on environment and energy R&D is 1.8 per cent and 5.4 per cent respectively³⁵. Considering the number of the patents in low-carbon technology, France is in the world top ten, having a significant presence in all wind, photovoltaic, biomass, CSP and clean coal technology, but well below the big four (US, JP, DE, CN)³⁵. According to a WWF study³⁶, France ranks 8th on clean energy technology top sellers worldwide and ranks

²⁸ Annual European Union greenhouse gas inventory 1990–2008 and inventory report 2010. EEA technical report submitted to the UNFCCC Secretariat, 27 May 2010

²⁹ Energy Efficiency trends, Policies & Measures in FRANCE (1990-2007). Monitoring of Energy Efficiency in EU 27, Norway and Croatia (ODYSSEE-MURE), G. Chedin, D. Bosseboeuf, September 2009

³⁰ Bilan énergétique de la France pour 2009. Juin 2010, Commissariat général au développement durable - Service de l'observation et des statistiques

³¹ The renewable share into gross electricity consumption was 15 per cent in 1997, as is declared in the 2001/77/EC Directive annex

³² DIRECTIVE 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

³³ European innovation Scoreboard (EIS) 2009, Comparative analysis of innovation performance, Pro INNO Europe and European Commission Enterprise and Industry, ISBN 978-92-79-14222-2, 2010

³⁴ Science, technology and innovation in Europe. 2010 edition. Eurostat

³⁵ Who Owns Our Low Carbon Future? Intellectual Property and Energy Technologies. A Chatham House Report, September 2009

³⁶ Clean Economy, Living Planet - Building Strong Clean Energy Technology Industries. Roland Berger Strategy Consultants, study commissioned by WWF Netherlands, November 2009

12th if the sales are weighted by GDP. The afore-mentioned study shows that France has a particularly strong clean tech industry on biofuels and building insulation materials.

France is committed to encouraging the use of renewable energy; biomass (mainly solid) and hydro already having an important contribution to the energy mix. Wood biomass represented some 9Mtoe in 2008 (4.8 per cent rise in 2007) and is the main renewable energy source in France. Wind energy can be considered the emerging low-carbon technology in France, representing around 60 per cent of all new power generation capacity in 2008. According to the Global Wind Energy Council³⁷ and the European Wind Energy Association (EWEA)³⁸, at the end of 2009 the total installed capacity was 4.49 GW, representing an annual growth rate of 32 per cent, after a 38 per cent growth rate over the previous year. Wood represents 9,91Mtoe (2007) and is the main source of renewable energy in France. The second renewable energy source in France is hydro, which counted (in 2007) for 14.5 per cent of French electricity production³⁹. Photovoltaics boast significant growth rates as well, with a 115 per cent growth over 2008⁴⁰.

The final energy intensity (final consumption per unit of GDP) (with climatic correction) has decreased by 18.5 per cent since 1990 also due to energy efficiency measures implemented in all the sectors. Since 2006 France's energy consumption is on track to meet the target of the French energy law (-2 per cent/year until 2015).⁴¹

2.2. STRATEGIES AND SUPPLY-SIDE POLICY FOR LOW-CARBON INNOVATION

Over the last years France has made important steps in supporting the deployment of low-carbon technology energy due to several changes of the energy political framework. In 2004 the French Government proposed a **Climate Plan**, reinforcing the national programme against climate change and proposing additional measures to comply with the French commitments according to the Kyoto Protocol. The Plan included some 60 measures aimed to reduce GHG emissions, to multiply by five biofuel use by 2010 and tax breaks up to 40 per cent for clean energy appliances such as boilers, solar water heaters and high-insulation windows. The measures proposed for the transport sector (i.e. tax rebates for low emission cars, tax penalties for high emission cars) were largely watered down due to car industry opposition. The plan was criticised by environmental groups as lacking substance.

The Energy Law from 2005 set the ambitious objectives to divide by four GHG emissions by 2050, to reduce energy intensity by 2 per cent per year until 2015 and to promote renewable energy use (10 per cent of the energy consumption should be by renewable by 2010). Importantly, the Energy Law announced the introduction of a mandatory energy savings trade certificates system for energy companies (a white certificate scheme).

In 2007, the French Government established the **Environment Round Table ("Grenelle de l'environnement")** which aims to define a national plan for the environment and to raise key points of government policy on ecological and sustainable development issues for the coming years. The Grenelle de l'environnement, an innovative policy measure, brought together for the first time state representatives,

³⁷ <http://www.gwec.net/index.php?id=11>

³⁸ EWEA, wind power and wind turbine database http://www.thewindpower.net/statistics_countries.php data from 2009

³⁹ Renewable Energy Policy Review. France. Factsheet elaborated in the framework of the EU project: RES 2020: Monitoring and Evaluation of the RES Directives implementation in EU27 and policy recommendations to 2020. EREC 2009

⁴⁰ État des énergies renouvelables en Europe. eurobserv'er, édition 2009

⁴¹ Energy Efficiency trends, Policies & Measures in FRANCE (1990-2007). Monitoring of Energy Efficiency in EU 27, Norway and Croatia (ODYSSEE-MURE), G. Chedin, D. Bosseboeuf, September 2009

business, trade unions, NGOs, local authorities and employers to draw up an action plan of concrete measures to tackle environmental issues. The Round Table is organised in six working groups on climate change, biodiversity and natural resources, health and the environment, production and consumption, democracy and governance, and competitiveness and employment. Following the debate, several important recommendations arise for boosting the implementation of clean energy and energy efficiency:

- Financing: to invest €1 billion in clean energy over the following four years as part of wide-reaching environmental plan to cut emissions of greenhouse gases, including proposals for ecological taxes, i.e. a project of a tax based on goods and services energy consumption ("carbon tax");
- GHG emissions: 75 per cent reduction by 2050, with significant reductions for the building and transport sectors, accounting for around 40 per cent of the actual emissions;
- Renewables and energy consumption: 20 per cent reduction in France's energy consumption by 2020 and a boosting of the use of renewable energy, such as wind power and biofuels, by 20 per cent by 2020;
- Building sector: generalisation of standards of low consumption in new housing and public buildings⁴², plus establishing incentives for the renovation of housing and heat buildings; rehabilitation of around 800,000 buildings to at least halve their energy consumption. A 38 per cent reduction is required in the energy consumption of the existing building stock by 2020;
- Transport:
 - a series of green taxes including a tax on the most polluting vehicles, as well as a tax on transport trucks crossing France's borders; and
 - freight to be transported on new high speed rail lines and waterways rather than highways; construction of 1500km of clean public transport ways (mainly high speed railway), creating a tax system favouring the least polluting vehicles, and the establishment of an environmental tax levied on trucks on the roads.
- Agriculture: 30 per cent of farms to be 'low energy' by 2013.

The recommendations were transposed into legislation by the law **2009-967 from 2009, known also as Grenelle 1**⁴³, with funding and rules for implementation specified by the 2009 Finance Law, the multi-annual public finance law and the national recovery plan (around 35 per cent of the plan's measures are oriented on fostering the implementation of the Grenelle). In June 2010, the French Parliament adopted the **Grenelle 2**⁴⁴, setting the application and the regional schemes for the Grenelle recommendation and Grenelle 1. The total cost of the Grenelle 1 has been estimated at around €120 billion, representing an annual average of €12 billion investment (0.6 per cent of GDP).

Ecotech 2012⁴⁵ is the ongoing French environmental technology plan for stimulating eco-industry development. Ecotech 2012 finances R&D as well as providing investment support through incentives, by creating new financial tools and by providing incubation type support for new SMEs. The programme also creates a monitoring scheme for controlling the 'environmental dumping' on car emissions labelling, energy performance of windows and lighting equipments etc.

⁴² new energy performance norms will have to apply to public and tertiary buildings (primary energy consumption not exceeding of 50kWh/m²/ year in average) by 2010 and to all buildings by 2012. A "Positive energy building" norm for all building will enter force by 2020.

⁴³ LOI no. 2009-967 du 3 août 2009 de programmation relative à la mise en œuvre du Grenelle de l'environnement (1)

⁴⁴ Communiqué de Presse : Adoption définitive du projet de loi portant engagement national pour l'environnement dit 'Grenelle 2', Paris, le mardi 29 juin 2010

⁴⁵ http://www.industrie.gouv.fr/liste_index/ecotechnologies.htm

The **French National Strategy for Research and Development in the field of Energy** (2009) aims to increase energy security, to reduce greenhouse gas emissions and mitigate climate change. It thus seeks to promote R&D in technologies and energy sources that limit GHG emissions and/or increase energy efficiency. In the field of renewable energy, the Strategy emphasises the need for stimulating low-carbon R&D and innovation in the following areas:

- Biomass, for electricity production, heating, and used as a fuel
- Photovoltaic energy
- Other renewable energies, for whose development the criteria will be: the energy potential, contribution to energy independence, environmental impact (including emissions and waste), the type of technological barriers, the presence and motivation of actors able to develop them.

In July 2010, a new French **Sustainable Development Strategy** for the period 2010-2013 was adopted by the government. This strategy follows the previous one from 2003-2008, considering the last developments of the EU and national policy resulted from the Grenelle 1. The 2010-2013 strategy lists around 50 objectives in nine areas including climate and energy, transport and consumption and production. New indicators have been added, such as France's carbon footprint. In total, the new strategy contains 19 indicators that will be made public each year from 2011.

ADEME is the national agency in charge of implementing environmental, renewable energy and energy efficiency policies, but low-carbon policy is divided among several ministries.

2.3. SME'S SUPPORT AND TECHNOLOGY TRANSFER

Established in 2005, OSEO is a French public organisation that funds and advises SMEs. Part of OSEO's activities involves supporting innovation in SMEs and, since 2008, in larger enterprises meeting similar barriers to innovation as SMEs.

OSEO Innovation offers a combination of grants and zero-interest advance payments to SMEs and larger enterprises for research, development, innovation and deployment activities, with the latter accounting for the majority of financial support.

Support for research, development and innovation in industry and industrial services is offered to SMEs and companies with up to 5000 employees. Separate funding is also provided through grants and interest-free advances to public research organisations to help SMEs for the development of methodologies, norms, models or new procedures for market deployment of new technologies. OSEO Innovation also provides support to SMEs that have little experience with innovation activities, through funding for technical feasibility studies and for obtaining patents. In addition, OSEO Innovation provides loans to companies requiring investment in non-technical aspects of developing new products, production tools, technologies and market deployment.

In 2007, OSEO supported 208 projects in the field of energy to the sum of 27.4 million euro. These included use of technology for improved energy consumption monitoring, high-efficiency construction materials, and a variety of renewable energy projects. The latter include biomass heat production projects, building construction using renewable energy, and solar photovoltaic technology development. Most projects supported the rational use of energy in buildings, industry and transport, followed by biomass, hydrocarbon, and solar energy production.

Since January 2008, the **Industrial Innovation Agency (All)** has been incorporated into OSEO, along with any existing projects it was supporting. The new programme stemming from this fusion is called **Strategic Industrial Innovation (ISI)**, and had a budget of €300 million for 2008. ISI targets not only SMEs but companies with up to 5000 employees. ISI supports collaborative projects between research centres and enterprises, aiming at research, development and deployment. The projects must be led or headed by a leading enterprise. ISI seeks to promote programmes that address major preoccupations and challenges, including reducing energy consumption, promoting clean transport, zero-emission energy production and increased use of renewable energy⁴⁶.

2.4. DEMAND-SIDE POLICY FOR LOW-CARBON INNOVATION

The regulatory framework comprises several important provisions for the promotion of low-carbon technology in France. The existing market schemes are quite complex, consisting of feed-in tariffs for renewables, a white certificate scheme for energy savings, tax rebates, financial support, preferential credits and support schemes for research, subsidies and incentives, innovation and start-up of SMEs. The following table summarises the main low-carbon technologies market deployment policies in France⁴⁷.

Market policy for low-carbon technology	Feed-in tariff/premium	subsidies / grants/rebates	Investments/tax credits	Energy/sales/excise taxes or VAT reduction	Tradable certificates	Public investments, loans or financing	Public procurement
	x	x	x	x	x	x	x

Green public procurement is reinforced by the Grenelle and there is in place a national plan for **Sustainable Public Procurement**, several guidelines for different products and public organisations as well as a cross-ministerial site for Eco-responsible Administration⁴⁸.

In 2006, France announced a series of **public-private research partnerships**, including three to reduce dependence on petroleum products and mitigate climate change. Projects slated to receive substantial public funding from the Agency for Industrial Innovation (All), included an €88 million programme to improve energy efficiency in buildings and a €62 million initiative to develop new energy-efficient metro trains. The French Government developed several **voluntary agreements** schemes for retailers in order to reduce GHG emissions, to increase energy efficiency and to encourage renewable energy use. Among these, the French Ministry of Ecology, Energy, Sustainable Development and Planning signed in 2008 a five-year agreement with the Federation of Retail and Distribution Enterprises⁴⁹, representing 26,500 outlets nationwide. The agreement commits the retail sector to establishing packaging waste and greenhouse gas emission reduction goals. Retailers agreed to undertake detailed analysis of the CO₂ emissions of all their activities, to better assess emissions from merchandise transportation and in-store activities. They also pledged to improve energy efficiency in stores, by switching to low-energy lighting and upgrading refrigeration and freezer systems. They also committed to acquiring at least 20 per cent of their overall

⁴⁶ <http://www.iea.org/textbase/pm/index.html>

⁴⁷ Table based on: Renewable 2010. Global status report (REN21)

⁴⁸ <http://www.ecoresponsabilite.environnement.gouv.fr/index.php>

⁴⁹ Les entreprises du commerce et de la distribution s'engagent sur un commerce durable: <http://www.fcd.asso.fr/index.php?page=17>

energy use from renewable energy sources by 2020. Retailers agreed to double the number of products bearing EU certified eco-labels over the next three years and to design and implement a new sustainable commerce communication plan.

The French Government creates a €10 billion fund for the financing of domestic energy conservation projects with low-interest loans. Available from 2007, the low-interest loans are based on a previous tax-free savings account known as the **CODEVI (Compte pour le Développement Industriel)**. This savings product allowed banks to finance the development of SMEs. CODEVI, as of 2007 has been renamed the **LDD (Livret de Développement Durable)**, and banks must use a portion of these funds to offer preferential loans for domestic energy conservation projects. **Preferential loans** can be awarded to individuals, co-properties and entrepreneurs for the purchase and installation of equipment producing energy from renewable sources; space and water heating equipment using wood or other biomass; heat pumps.⁵⁰ In July 2008, a **demonstration fund**⁵¹ was created by three government ministries to provide €400 million over four years to help finance the development of energy technologies for which there is currently no viable market. The fund targets manufacturers or public-private partnerships in need of financing for high-cost demonstration projects with experimental goals, for which market prospects are long-term. For 2008, the fund had three calls for proposals in the areas of carbon capture and storage, renewable energy (second generation biofuels) and innovative transport systems, with low energy consumption and/or reduced greenhouse gas emissions.

The 2009 Finance Law contains various provisions to increase support of renewable energy and for energy savings through building renovation (improving building insulation, more efficient heating systems, renewables for thermal energy). The Law introduces an **eco-loan with zero interest rate for energy-efficient renovation** with the aim to repay the loan from the energy cost reductions achieved by energy savings. The 2009 Finance Law includes some provisions on progressive reduction of the **consumption taxes for biofuels**.

In 2005, the government recalibrated the **tax credits for purchases of equipment for primary residences to promote sustainable development and energy conservation**. Specifications were modified again in 2009, when the credit was extended to December 2012 (from end of 2009). To be eligible for the tax credits the building in which the equipment is used must be a primary residence and at least two years old; for renewable energy equipment the building can be new or old. The tax credits are for low-temperature boilers, heating regulation devices, thermal insulation improvements and renewable energy for heating.

In February 2009, the French Government launched a **plan to improve the energy efficiency of agricultural exploitations**⁵². The plan will support the Grenelle de l'Environment objective of having 30 per cent of agricultural exploitations be low-energy consumption by 2013. Among the eight main targets of the plan are the promotion of related research and innovation, the improvement in energy efficiency of agricultural equipment and processes and the use of renewable energy such as the methane, biomass and photovoltaic systems. The plan gives financial support for investing in measures to contribute to achieving the these objectives.

⁵⁰ Les modalités de fonctionnement du Livret de développement durable:

[http://www.fbf.fr/Web/internet/content_particuliers.nsf/\(WebPageList\)/Les+modalites+de+fonctionnement+du+Livret+de+developpement+durable+sont+precisees?Open](http://www.fbf.fr/Web/internet/content_particuliers.nsf/(WebPageList)/Les+modalites+de+fonctionnement+du+Livret+de+developpement+durable+sont+precisees?Open)

⁵¹ <http://www2.ademe.fr/servlet/getDoc?cid=96&m=3&id=54950&p1=1>

⁵² Plan performance énergétique des exploitations agricoles (2009-2013) :

<http://agriculture.gouv.fr/sections/presse/dossiers-presse/plan-performance>

Under the **Electricity Law 2000**, **feed-in tariffs** for stimulating the renewable energy were introduced in 2005 and 2007 (for hydro). Feed-in tariffs are currently introduced for biogas, onshore and offshore wind power, photovoltaic and geothermal energy. These apply for contracts of 15 years, except for hydropower, off-shore wind power and photovoltaics, for which they apply to contracts of 20 years. From December 2009 new feed-in tariffs for biomass electricity are in place. These apply to vegetable and animal agricultural waste, algae and some industrial biomass waste (pulp and paper, wood industries), but do not cover biogas, household or municipal waste. New feed-in tariffs for photovoltaic electricity were established in January 2010. The tariffs, in place for 20 years, are indexed annually and will be reduced by 10 per cent annually after 2012. The regime applies to three broad categories of solar PV: building-integrated installations, simplified building-integrated installations and ground-mounted solar installations⁵³.

Under the French **White Certificates scheme**, suppliers of energy (electricity, gas, heating oil, LPG, heat, refrigeration) must meet government-set targets for energy savings achieved through the suppliers' residential and tertiary customers. Suppliers are free to select the actions to meet their objectives, such as informing customers how to reduce energy consumption, running promotional programmes, providing incentives to customers and so on. A list of ratified activities was drawn up to help the various actors to facilitate the operations. Those exceeding and undercutting their objectives can trade energy savings certificates as required for common compliance.

A programme to coordinate policies on research and innovation in land transportation, **PREDIT** has been in place since 1990. In February 2009, the French Government launched the fourth PREDIT programme. PREDIT 4⁵⁴, with a budget of approximately €400 million, which will run from 2009-2012; the first of its six priority areas is energy and environment. A sub-programme on transport policy emphasises sustainable mobility and climate change with the aim of developing coherent policy and appropriate economic and regulatory tools.

On December 2007 a combined bonus and penalty system (**Bonus-Malus programme**)⁵⁵ was announced to encourage the purchase of low-polluting vehicles. The bonus system applies to new vehicles and provides a state subvention or a penalty, function of the CO₂ emissions of the purchased new vehicle. The scheme is considered a success story and the French Government has attributed a 45 per cent increase in 2008 sales of cars emitting 130g CO₂/km or less, and a 42 per cent drop in sales for those emitting more than 160g CO₂/km to the Bonus-Malus.

In 2009, France detailed a **new carbon tax with a new levy on oil, gas and coal consumption by households and businesses**, supposed to enter in force during 2010. However, the carbon tax was blocked by the French Constitutional Council, considering that it will introduce too many exceptions⁵⁶.

⁵³ <http://www.developpement-durable.gouv.fr>

⁵⁴ <http://www.predit.prd.fr/predit4/homePage.fr>

⁵⁵ http://www.developpement-durable.gouv.fr/spip.php?page=article&id_article=15498

⁵⁶ France to rethink carbon tax plan, BBC: <http://news.bbc.co.uk/2/hi/8434505.stm>

3. GERMANY

3.1. LOW-CARBON INNOVATION CONTEXT

Germany has the toughest target among the EU countries under the Kyoto Protocol and the European Council's Decision on burden sharing, consisting of a 21 per cent GHG emissions reduction by 2012 (compared to the baseline). In 1990, Germany was by far the main pollutant in EU, with some 1231.8 million tonnes CO₂ equivalent, with a strong industrial sector and an energy generation sector dominated by oil and coal. In 2008, Germany already surpassed the Kyoto target, reaching a 22.3 per cent emission reduction (compared to the baseline)⁵⁷.

Due to a strong, stable and predictable policy framework, Germany reached significant results in implementing low-carbon energy technology, becoming the world's first major renewable-energy economy⁵⁸. In 2009, Germany was the world investment leader (together with China), spending around €25 billion on new low-carbon energy capacity⁵⁹. The share of electricity from renewable energy in Germany increased from 6.3 per cent in 2000 to about 16.1 per cent in 2009, surpassing in 2007 the indicative target of 12.5 per cent renewable energy electricity by 2010⁶⁰ as set in the EU renewable electricity Directive⁶¹. Implementing the renewable energy Directive⁶², Germany has a mandatory target of 18 per cent share of renewables in the gross energy final consumption by 2020 (the renewable share was 10.1 per cent in 2009, having a 8.6 per cent growth comparing to 2008). However, despite the impressive performance in implementing low-carbon technology and energy efficiency measures, the primary energy supply is still dominated by oil and gas. Germany still has a 65 per cent dependency on fossil fuels imports.

Germany has one of the strongest world economies with a very well developed industry, based on a strong research sector involving public and private research and academia. In 2007 according to Eurostat⁶³, Germany has a 2.54 R&D intensity (R&D expenditure as a percentage of GDP), well above the EU average (1.85). Around 70 per cent of these funds went to the private sector research, 16 per cent to the public research and 14 per cent to the high education research. The share of the public expenditure on environment and energy R&D is 3.2 per cent and 3.5 per cent respectively⁷. According to the last European Innovation Scoreboard⁶⁴ Germany is one of the innovation leaders with performances considerably above the EU-27 average, being at the same time among the main worldwide innovation leaders. Germany is the second biggest global innovation hub (after US), having a significant number of patents in almost all low-carbon technology⁶⁵.

⁵⁷ Annual European Union greenhouse gas inventory 1990–2008 and inventory report 2010. EEA technical report submitted to the UNFCCC Secretariat, 27 May 2010

⁵⁸ Germany: The World's First Major Renewable Energy Economy, Renewable Energy.com, April 2009

⁵⁹ Renewable 2010. Global status report (REN21)

⁶⁰ Big boost for renewable energies. Share in electricity supply has gone up to 14 per cent. Communication No. 006/08 Berlin, 22.01.2008 of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

⁶¹ Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity from renewable energy sources in the internal electricity market

⁶² DIRECTIVE 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

⁶³ Science, technology and innovation in Europe. 2010 edition. Eurostat

⁶⁴ European innovation Scoreboard (EIS) 2009, Comparative analysis of innovation performance, Pro INNO Europe and European Commission Enterprise and Industry, ISBN 978-92-79-14222-2, 2010

⁶⁵ Who Owns Our Low Carbon Future? Intellectual Property and Energy Technologies. A Chatham House Report, September 2009

Germany's long tradition in engineering and technology built the basis for its leading low-carbon energy technology industry. Germany excels in a broad range of technologies, most significant in wind, photovoltaic, biodiesel, biogas and building insulation materials⁶⁶. Impressive figures describe the low-carbon technology deployment in Germany. Germany has the second highest installed wind power capacity in the world (after US), representing 6,5 per cent of total gross electricity consumption in 2009 and a wind power installed capacity of 25777 MW. In 2009, the electricity generated by photovoltaics broke through the 1 per cent threshold of Germany's electricity consumption, with a more than 40 per cent growth rate in only one year and around 8,77GWp⁶⁷ overall cumulative installed capacity. In 2007, Germany passed Japan to lead the world in PV manufacture, producing an estimated 1063 MW of solar cells, by 56 per cent more than in 2006⁶⁸.

Biomass (mainly for heat) remains the main renewable energy source, representing around 7 per cent of overall renewable energy in final energy consumption. Solar thermal capacity is continuing to increase: there were around 13 million m² of solar collectors in 2009, producing 8,896 MW and accounting for 0.4 per cent of Germany's total heat consumption. Significant market development has taken place geothermal energy technology, with an annual 8.7 per cent growth in the use of heat-pumps⁶⁹.

According to ODYSSEE-MURE, energy consumption in Germany has continued to grow slowly, despite the fact that the energy efficiency measures have had a significant impact in Germany, contributing to a 23 per cent improvement in energy efficiency between 1991 and 2007⁷⁰.

Support for low-carbon innovation in Germany is complex, ranging from research, development and technology transfer of products and technologies to providing business models, services and consulting with a large number of thematic technology clusters and networks. The balance between supply 'push' and demand 'pull' policies is very well designed for almost all low-carbon technologies, in accordance with natural resource and economic potential. Financial support for low-carbon innovation and deployment is among the biggest worldwide, with a consistent industry contribution and complemented by important, dedicated, low interest credit lines.

3.2. STRATEGIES AND SUPPLY-SIDE POLICY FOR LOW-CARBON INNOVATION

The German low-carbon strategy is consistent and clear targets are set, with a good balance between state and private financing, with varied sources of information and several well developed collaborative clusters between SMEs, universities and research bodies as well as with a strong support for international cooperation.

The German **National Sustainability Strategy**⁷¹ (2002) sets the general framework and lays out policy directions and targets on climate and energy, on sustainable management of raw materials and on the

⁶⁶ Clean Economy, Living Planet - Building Strong Clean Energy Technology Industries. Roland Berger Strategy Consultants, study commissioned by WWF Netherlands, November 2009

⁶⁷ Development of renewable energy sources in Germany in 2009. Presentation by Federal Ministry for the Environment, Nature Conservation and Nuclear safety

⁶⁸ Another Sunny Year for Solar Power. Worldwatch Institute, 2008

⁶⁹ Development of Renewable Energy Sources in Germany 2009. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), March 2009

⁷⁰ Energy Efficiency Policies and Measures in Germany. Monitoring of Energy Efficiency in EU 27, Norway and Croatia (ODYSSEE-MURE), Fraunhofer Institute for Systems and Innovation Research (Fraunhofer ISI), 2009

⁷¹ The National Sustainability Strategy:

<http://www.bundesregierung.de/Webs/Breg/EN/Issues/Sustainability/sustainability.html>

global social opportunities posed by demographic change and food. The targets on climate change and energy are in line with the EU commitments for GHG reduction by 2012 (21 per cent lower than 1990) imposing at the same time two ambitious milestones for energy consumption and generation: energy production is to be doubled by 2020 and power generation from renewable sources is to account for at least 30 per cent by 2020. The strategy is carefully monitored by regular, detailed reports which are discussed and analysed by main market and social actors from business, academia, consumer and environmental associations, trade unions, churches and the media.

Germany has a strong R&D policy, with around 500,000 people involved in R&D activity, more than 130 networks of excellence and international multilateral cooperation with around 40 countries. The overall R&D budget is more than €55 billion per year, of which two thirds comes from industry⁷². Government reports show that the R&D expenditure of business enterprises more than tripled from 2005 to 2008; a good explanation of Germany's top ranking in global research and innovation.

The research, development and demonstration of low-carbon technology is driven by **the 5th Energy Research Programme 'Innovation and New Energy Technologies' (INET)**⁷³ and by the **High-Tech Strategy for Germany**⁷⁴.

INET was launched as part of the government's 'Innovation Initiative' and covers the period up to 2010. INET's priority funding areas are energy efficiency and low-carbon energy technologies. An important aim of INET is to create favourable conditions for the German electricity industry to use cutting edge low-carbon technology in the programme of power plant replacement due to begin in 2010.

The High-Tech Strategy for Germany is a national initiative in 17 key technology fields, aiming to set new R&D priorities, to create lead markets, to strengthen the bridges between industry and research bodies and to improve the framework conditions for innovation in industry. The strategy is specifically targeted to promote technologies and actions and thereby to secure lasting success in fields of research and development. It is the first national initiative to embrace all ministerial departments. Around €15 billion are to be invested up to 2010 in cross-cutting technologies and cross-technological solutions for fostering research transfer into new products, services and processes. The strategy also aims to pool the forces and resources of industry and science and to provide better conditions for high-tech start-ups and innovative SMEs. Among the 17 key fields of the strategy a significant role is given to the energy and environmental technologies.

Implementing the High-Tech Strategy, the German Federal Government launched the **Environmental Technologies Master Plan**⁷⁵ with the aim to open up future lead markets more effectively and to continue improving the framework conditions for innovation. In its first stage, the Master Plan is focuses on water, raw materials and climate protection (including low-carbon energy). Later on, further activities will be added and developed, based on the BMBF Foresight Process and on the results of the 'Roadmap Environmental Technologies 2020' project. The Roadmap's 'State-of-the-art Report' confirms that there is great innovation potential, not least in the area of resource efficiency. The Roadmap was foreseen to be completed in 2009 and to form the basis for various possible courses of action that are in keeping with current funding policies.

⁷² <http://www.research-in-germany.de/2866/research-landscape.html>

⁷³ Innovation and New Energy Technologies. The 5th Energy Research Programme of the Federal Government, Berlin, July 2005 <http://www.bmwi.de/English/Navigation/Service/publications.did=74976.html>

⁷⁴ 'The High-Tech Strategy for Germany', Federal Ministry of Education and Research (BMBF), Bonn/Berlin 2006 <http://www.hightech-strategie.de/en/>

⁷⁵ High-tech Strategy website: <http://www.hightech-strategie.de/en/350.php>

For supporting the climate and energy goals of the national strategy was launched **the Integrated Energy and Climate Programme (IEKP)**⁷⁶. The IEKP has the general aim to promote innovative technology for improving energy efficiency, for increasing renewable energy use and for reducing GHG emissions on both the supply side and the demand side. IEKP is in line with the 5th Energy Research Programme and lays the foundations for state-of-the-art, low-carbon energy supply and includes steps towards ambitious and efficient climate protection. IEKP proposes a package of 29 measures with legal changes and investments in research and development, mainly for supporting energy efficiency and renewable energy. Among the most important measures are proposed amendments to the **Energy Conservation Act**, to **the Energy Conservation Ordinance (EnEV)**, to **the Renewable Energy Sources Act (EEG)** and to **the Renewable Energies Heat Act (EEWärmG)** as well as measures for facilitating biogas feed-in and the reform of the vehicle tax on the basis of CO₂ emissions. IEKP sets new targets for increasing the renewable energy share of final energy consumption of the heat sector to 14 per cent by 2020 (from 7.5 per cent currently) and for an 8 per cent biofuels share in transport consumption by 2015 (by **The Biofuel Act**).

3.3. SME SUPPORT AND TECHNOLOGY TRANSFER

Germany has gradually increased its innovation demand-side policy by developing several new initiatives for industry and SMEs. The research, development & demonstration (RD&D) policy gives particular attention to increasing the networking activities between industry, public research and academia, including by creating thematic innovation clusters for stimulation of research-industry partnerships.

Central Innovation Programme SMEs (ZIM) is the basic programme by the Federal Ministry of Economics and Technology (BMWi) for market-oriented technology funding of innovative SMEs in Germany. Funding is provided for cooperation projects between SMEs, or SMEs and public or private non-profit research institutions, including projects from SMEs that have not yet shown much of an innovative streak and R&D contracts for the preparation of future cooperations and networks. R&D projects are for the development of innovative products, procedures or technological services and are not restricted to specific technologies or sectors. ZIM has received significant additional funds of about €450 million for both 2009 and 2010⁷⁷.

Innovation Alliances⁷⁸ are a new instrument for research and innovation policy within the framework of the High-Tech Strategy initiated by the Federal Ministry of Education and Research (BMBF). Currently there are six innovation alliances, created together with the scientific community and industry. Innovation alliances are arranged with respect to specific application areas or future markets, with the aim of having an economic leverage effect. The target is to reach a ratio of 1:5 between public and private investments. This investment policy is also important for boosting SMEs' activities, since knowledge of future technological developments, together with commitment from large companies, enables SMEs to remove some of the uncertainty and high risks associated with R&D investment decisions. Funding is around €500 million from the Federal Government and €2.6 billion from industry.

In Germany there are different opportunities and schemes for technology transfer, tailored according to different market actors. Among them, **the Helmholtz Association** intends to combine research and technology development with innovative application and precautionary perspectives. This also includes

⁷⁶ Key Elements of an Integrated Energy and Climate Programme Decision of German Cabinet on August 23rd/24th 2007 at Meseberg, Federal Ministry for Environment, Nature Conservation and Nuclear Safety

⁷⁷ 'Eco-innovation in industry. Enabling the green growth', ISBN: 978-92-64-07722-5, OECD 2009

⁷⁸ Innovation alliances: <http://www.research-in-germany.de/research-landscape/rpo/networks-and-clusters/41832/10-3-innovation-alliances.html>

permanent exchange with industry in all the stages of research and the production of knowledge. In practice, in the short and medium term companies benefit from technologies, scientific results, know-how and services which are applied to new products and techniques through cooperation with Helmholtz research centres.

The **Environmental Innovation Programme**⁷⁹ supports pilot projects applying state-of-the-art technologies in Germany on a large scale. Around €700 million have been provided for more than 700 pilot projects since the start of the Programme.

The Federal Ministry of Economics and Technology (BMWi) and KfW bank have established the **Special Fund for Energy Efficiency in SMEs**, to tackle both the informational and cost barriers faced by SMEs aiming to implement energy efficiency measures. The programme has two components: an advice component and a financing component. The advice component provides grants for SMEs to obtain advice and consultation regarding energy efficiency. The financing component provides SMEs with low-interest loans for investment in energy conservation measures.

The Federal Ministry of Economics and Technology (BMWi) and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) together with the Association of German Chambers of Industry and Commerce (DIHK) started a joint project called "**Partnership for climate protection, energy efficiency and innovation**", designed to support SMEs in making use of energy consulting services. The aim of this initiative is to cause a marked rise in demand for such services.

International cooperation is well supported by the federal funding programmes for cooperation between Germans SMEs and other countries worldwide, at all the stages of research, technological transfer and business oriented cooperation. The Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)⁸⁰ is a federally owned organisation operating in around 128 countries in the field of international cooperation for sustainable development, including low-carbon technology innovation and deployment. The GTZ supports the German Government in achieving its development objectives, working on behalf of German ministries, international clients and private companies.

3.4. DEMAND-SIDE POLICY FOR LOW-CARBON INNOVATION

Germany has one of the best organised systems to encourage and deploy low-carbon innovation, with a strong state support for product and process innovation, and based on several market instruments like feed-in tariffs for renewables and tax deductions for energy saving measures in buildings.

National policies for energy efficiency and renewable energy deployments support the implementation of the National Energy Efficiency Action Plan (under the ESD Directive) and of the National Renewable Energy Action Plan (under the Renewable Energy Directive).

The following table summarises the main low-carbon technology market deployment policies in Germany⁸¹.

⁷⁹ http://www.kfw-mittelstandsbank.de/EN_Home/index.jsp

⁸⁰ <http://www.gtz.de/en/>

⁸¹ Table based on: Renewable 2010. Global status report (REN21)

Market policy for low-carbon technology	Feed-in tariff/premium	Subsidies / grants/rebates	Investments / tax credits	Energy/sales/excise taxes or VAT reduction	Public investments, loans or financing	Public procurement
	x	x	x	x	x	x

Guidelines on public procurement have been published which offer extensive guidance for a wide set of products and services⁸². Critics believe the public procurement legislation is too complicated; indeed, the European Commission has asked Germany to simplify it. The draft legislation regarding the modernisation of public contract award law adopted by the German Government in 2008 will make, for the first time, environmental protection a goal that must be taken into account by law. However, for the time being it is still waiting for approval from the German Bundestag⁸³.

At the beginning of 2008 the Federal Government implemented a comprehensive **National Climate Initiative**⁸⁴. The goal of the Climate Initiative is to tap existing potential for reducing emissions in a cost-effective way and to advance innovative model projects for climate protection. Specifically, climate protection measures for increased energy efficiency and greater use of renewable energies should be promoted. The focus of the National Climate Initiative is on consumers, industry and municipalities and on social and cultural establishments. The support programmes and individual projects aim to:

- advance climate-friendly technologies in a targeted way
- demonstrate and disseminate innovative climate technologies using model projects and
- identify and overcome barriers preventing the implementation of climate protection measures.

Five support programmes have been published so far as part of the national initiative:

- Guidelines on promoting climate protection projects in municipalities and in social and cultural establishments
- Climate incentive programme for the installation of mini-CHP plants (CHP: combined heat and power) in private households and commercial enterprises
- Climate incentive programme for commercial refrigeration plants
- A programme for promoting projects to optimise biomass energy use and
- An extension of the existing market incentive programme for renewable heat.

The Market Incentive Programme⁸⁵ supports installations using renewable energy by providing investment grants, low-interest loans and repayment grants. The focus is on heat generating facilities such as solar panel installations, solid biomass plants and efficient heat pumps for hot water and heating in buildings, as well as on larger installations such as deep geothermal installations, biomass heating plants and local heating grids which use renewable energy sources.

⁸² <http://www.umweltbundesamt.de/produkte-e/beschaffung/index.php>

⁸³ Environmental aspects in contract placement / Reform of German procurement law.

<http://www.umweltbundesamt.de/produkte-e/beschaffung/informationen/recht/umweltaspekte/reform.html>

⁸⁴ <http://www.foerderinfo.bund.de/en/2665.php>

⁸⁵ <http://www.biogaspartner.de/index.php?id=10178&L=1>

The KfW group (Kreditanstalt für Wiederaufbau Bankengruppe) is the ‘financial arm’ of the German Government for supporting the deployment of low-carbon technology. KfW was founded more than 60 years ago by the German federal Government (80 per cent) and the regional governments (20 per cent), and today makes a strong stand for climate and environmental protection both within Germany and abroad. KfW consists of five banks with tailored products for financing the start-up and life-cycle operation of SMEs, for energy efficiency and renewable energy investments of individual and institutional bodies, risk sharing finance and investment loans for German companies in external markets. KfW actively cooperates with the European Investment Bank (EIB) in many areas of low-carbon technology, particularly in financing energy and environmental technology SMEs and infrastructure investments in Central and Eastern Europe. In conjunction with EIB, KfW launched in 2009 a new global carbon fund for carbon-saving projects providing an outlet for new forms of carbon credit from developing countries and providing help to local SMEs and institutions to meet environmental requirements⁸⁶. In 2009, KfW achieved the highest domestic promotional business volume in its history with €5.9 billion, maintaining at the same time a strong presence of €74.4 billion on international capital markets. Besides supporting SMEs and fighting the consequences of the recession, climate and environmental protection were the main areas of promotion with a contribution of €20 billion to investments in Germany and abroad.

The German low-carbon market is strongly regulated by several acts and ordinances giving incentives and fair market access to renewable energy, i.e. the Renewable energy Act, the Co-generation Act and the Renewable energy heat Act etc. The energy saving ordinance and rules for expansion of the electricity grids were revised in 2008.

The Renewable Energy Sources Act (EEG) introduced feed-in tariffs for electricity from renewable energy sources into the national grid at largely fixed fees. The EEG was modified in 2006 and 2009, following the development of the energy sector. In 2009 an amendment to the Renewable Energy Sources Act (EEG) came into force. It provides a higher feed-in tariff for wind energy, and other measures to stimulate the development of both onshore and offshore wind power. The 2009 amendment increased the feed-in tariffs for hydropower and geothermal energy and offered improved tariffs for small biofuel plants and biomass facilities with some extra bonuses if energy crops, waste biomass and manure are used.

The **Renewable Energies Heat Act (EEWärmeG)** aims to increase the share of renewable energies in heat provision to 14 per cent by 2020. The Act makes the use of renewable energy for space and hot water heating mandatory for new buildings. It also stipulates budget requirements to this end for **the Market Incentive Programme**. Owners of buildings that are to be newly erected are obliged by the EEWärmeG to use a certain percentage of renewable energy for heating purposes (water and space heating). The minimum percentage depends on the renewable energy technology used, as follows:

- At least 15 per cent for solar thermal installations;
- At least 30 per cent for gaseous biomass (under certain restrictions); and
- At least 50 per cent for all the others.

Alternative measures are also permitted:

- Energy Saving Regulation (EnEV) requirements for buildings must be increased by 15 per cent;
- At least 50 per cent of energy for heating purposes must be supplied by combined heat and power (CHP); and

⁸⁶ http://www.kfw.de/EN_Home/index.jsp

- Energy supply by a district heating network, if heating is generated mainly by the use of renewable energy technologies, waste heat or CHP.

The climate change programme in the building sector⁸⁷ is supported on various levels: information campaigns to incentivise measures for improving energy performance in buildings (funded by the state and KfW development loan cooperation programmes), energy certificates for buildings and Energy Conservation Regulations, and a 'Future construction' initiative. **The KfW**⁸⁸ energy-efficient rehabilitation programme and the support programmes for renewable energy investments offer attractive long-term, low-interest loans and repayment bonuses, accompanying the ongoing federal programmes and policy. Passive houses have become very popular in Germany: at present there are around 10,000 buildings that fulfil the passive house standard⁸⁹.

The **action programme "Climate in Schools and Educational Establishments"** comprises coordinated actions on energy saving, improved energy efficiency, the installation of renewable energy, the provision of teaching materials, the qualification of teaching staff, the implementation of model projects, the organisation of climate days and other projects to raise climate awareness.

In transport an **engine tax for passenger vehicles** was introduced, according to the level of emissions of pollutants and CO₂, and KfW has a distinct fund for financing the acquisition of low-carbon heavy duty company vehicles.

⁸⁷ <http://www.bmvbs.de/en/Building/>

⁸⁸ <http://www.kfw-foerderbank.de>

⁸⁹ The primary Passivhaus target criteria are a total heating & cooling demand less than 15 kWh/m²/yr and a total primary energy less 120 kWh/m²/yr.

4. THE NETHERLANDS

4.1. LOW-CARBON INNOVATION CONTEXT

Under the Kyoto Protocol and the European Council's Decision on burden sharing, the Netherlands has a 6 per cent GHG reduction target by 2012, but only a 2 per cent reduction had been achieved by 2008⁹⁰. The Netherlands must therefore intensify its carbon reduction efforts, though it is still possible to meet the target with just a 1 per cent reduction per year. Climate change is a significant worry in the Netherlands, being a geographically low-lying country, with about 20 per cent of its area and 21 per cent of its population located below sea level, and with 50 per cent of its land lying less than one metre above sea level.

The Netherlands is a producer and exporter of natural gas, but depends on imports of oil and coal (but below the EU average). Gas (44 per cent) and oil (40 per cent) dominate the aggregate energy supply⁹¹. With regard to implementing low-carbon energy technologies, the Netherlands has a mandatory target of a 14 per cent share of renewables in the gross energy consumption by 2020⁹² (the renewable share was 3.4 per cent in 2009⁹³). Implementing the renewable electricity Directive (2001/77/EC), the Netherlands has a 9 per cent target for the renewable share of gross electricity consumption by 2010, and already secured 7.5 per cent from 2008 – a 25 per cent increase from 2007, mainly due to a strong increase in wind power and biomass¹³⁰.

The Netherlands has a 1.7 R&D intensity (R&D expenditure as a percentage of GDP) – below the EU average of 1.85. Around 60 per cent of these funds went to private sector research, 13 per cent to public research and 27 per cent to higher education research. The share of public expenditure on environment and energy R&D is 1.6 per cent and 2.7 per cent respectively, rather low compared to the top performers in low-carbon innovation⁷. The Netherlands has a good education system and financial support for research and innovation, being among the innovation followers in the EU according to the last European Innovation Scoreboard⁹⁴. The rate of improvement in innovation performance was considered to be below the EU-27 average.

The Netherlands is among the top ten world innovation leaders – being particularly strong in biomass, cleaner coal, wind and photovoltaic technology, and having a significant number of patents – but well below the main world innovators⁹⁵. The innovation, climate change and resource-efficient economy have been coupled for several years, with the former being nowadays considered as a solution to the latter by both the government and environmental organisations. The reports of the Intergovernmental Panel on

⁹⁰ Annual European Union greenhouse gas inventory 1990–2008 and inventory report 2010. EEA technical report submitted to the UNFCCC Secretariat, 27 May 2010

⁹¹ EU energy and transport in figures. Statistical pocketbook 2010, ISBN 978-92-79-13815-7, European Union 2010

⁹² DIRECTIVE 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

⁹³ Renewable energy in the Netherlands 2008. Statistics Netherlands 2009

⁹⁴ European innovation Scoreboard (EIS) 2009, Comparative analysis of innovation performance, Pro INNO Europe and European Commission Enterprise and Industry, ISBN 978-92-79-14222-2, 2010

⁹⁵ Who Owns Our Low Carbon Future? Intellectual Property and Energy Technologies. A Chatham House Report, September 2009

Climate Change (IPCC) have had an impact on debate and policies, and the concern of the country being below sea level understandably gives further impetus⁹⁶.

The share of renewable energy in the Netherlands' primary energy consumption is increasing but remains quite low, registering 3.4 per cent in 2009. However, the Netherlands has significant installed wind power capacity (2.23GW in 2009⁹⁷) and a 2.9 per cent share of biofuels in transport. The most important sources of renewable energy are the co-firing of biomass in electricity power stations, wind energy, municipal waste incineration plants and – since 2007 – also the use of biofuels for road transport. Together, these four sources account for 71 per cent of renewable energy consumption in the Netherlands.

Overall energy efficiency has been improving steadily in the Netherlands from 1990-2007, with an average annual improvement of 1.2 per cent. An improvement of 1.8 per cent has been witnessed in the residential sector, mainly due to a higher penetration of more efficient equipment⁹⁸.

4.2. STRATEGIES AND SUPPLY-SIDE POLICY FOR LOW-CARBON INNOVATION

Low-carbon innovation is integrated in the overall transition management policy towards a low-carbon economy. The Dutch transition management policy opts for the simultaneous exploration of multiple options and adaptive policies, based on iterative and interactive decision making, aiming to lead to environmental- and cost-optimal solutions.

In September 2007, the Dutch Government launched the **New Energy for Climate Action Plan: Clean and Efficient**⁹⁹. The plan considers the EU climate and energy targets for 2020 and is consistent with those announced in the Energy Transition Programme. The action plan presents a set of measures to reach the climate and energy targets, targeted at each economic sector, using primarily market instruments ('polluter pays'), standards (e.g. energy consumption requirements for lighting, appliances and cars), temporary financial incentives (e.g. subsidies for renewable energy), innovation (with a primary emphasis on energy transition) and climate and energy diplomacy (including EU-level lobbying). The Clean and Efficient Action Plan has various sector-specific measures in buildings, energy, industry, transport and agriculture, as detailed in the following¹⁰⁰:

- Built environment:
 1. The More with Less Programme, an agreement with stakeholders across the building industry targeting existing buildings;
 2. A tightening of energy performance standards in building regulations aiming towards carbon neutral new buildings by 2020;
 3. The introduction of a subsidy scheme for the use of renewable energy sources in existing buildings; and
 4. Energy Performance Certificates (EPCs) to be produced for the sale or rental of existing buildings as January 2008.
- Energy production:

⁹⁶ Innovation, climate change and a more resource efficient economy. Policy Brief No4 (2010). A. Karakasidou & P. Cunningham, Manchester Institute of Innovation Research, University of Manchester, Pro-INNO Europe, 2010

⁹⁷ EWEA, wind power and wind turbine database http://www.thewindpower.net/statistics_countries.php data from 2009

⁹⁸ Energy Efficiency Policies and Measures in The Netherlands. Monitoring of Energy Efficiency in EU 27, Norway and Croatia (ODYSSEE-MURE), 2009

⁹⁹ <http://international.vrom.nl/pagina.html?id=37556>

¹⁰⁰ IEA database of climate policy: <http://www.iea.org/textbase/pm/?mode=cc&id=3679&action=detail>

1. A new subsidy scheme for large-scale renewable energy production, the SDE;
 2. CO2 emissions limitations placed on new coal-fired power stations; and
 3. The launch of two carbon capture and storage (CCS) demonstration projects.
- Industry:
 1. The launch of new and more ambitious long-term voluntary agreements with industry (the MJA);
 2. Establishing programmes with individual sectors to achieve energy savings of 50 per cent in their production chains by 2030 (paper and chemicals sectors have taken the lead); and
 3. Commitment to the EU Emissions Trading Scheme.
 - Transport:
 1. "Greening" taxes on the purchase of new cars (the BPM) by differentiating it further based on the car's energy and environmental performance;
 2. Extending the availability of natural gas and biogas at stations across the country;
 3. Targeting public transport, through hydrogen-fuelled public transportation demonstration projects, and demonstrations undertaken by municipalities with high efficiency buses;
 4. Commitment to European norms covering CO2 emissions for new cars; and
 5. Increasing the mandatory percentage of biofuels in transport after 2010, while developing strict sustainability criteria.
 - Agriculture
 1. Introducing a subsidy programme to help make greenhouses more energy efficient (heat and cold storage systems);
 2. Introducing an emissions trading system in 2011 specifically covering greenhouse horticulture;
 3. Making investments to reduce emissions from agriculture (changes to livestock feed, emissions from agricultural buildings, precision farming and fertilising to reduce nitrogen use); and
 4. Additional investments in manure fermentation for energy production (heating and electricity).

A milestone of the Netherlands energy and environmental policy was the fourth **National Environmental Policy Action Plan (NEPAP)**¹⁰¹, which proposed a 'transition management' approach in addressing complex environmental problems, aiming at system innovation in important societal domains like energy. This innovative approach sets a long-term framework for designing future policy objectives and pathways, with interim targets and short-term policies to facilitate the achievement of the targets¹⁰². The Dutch transition management approach is a very good example of an attempt to ensure policy coherence integrating many policy fields, most notably innovation, environmental and energy policy¹⁰³. Among other strategic plans, the NEPAP outlines programmes to promote flex-fuel vehicles, agricultural greenhouses and energy-neutral communities. By focusing on the aspects of domestic energy supply which the Dutch consider their expertise, the government seeks to take advantage of economic opportunities and improve the competitive position of the Netherlands, while reducing hazardous emissions.

¹⁰¹ <http://www.vrom.nl/pagina.html?id=37582>

¹⁰² Restructuring energy systems for sustainability? Energy transition policy in the Netherlands. F. Kern, A. Smith, Sussex Energy Group, SPRU, University of Sussex, Sussex Energy Group Working Paper

¹⁰³ Eco-Innovation. Final Report for Sectoral Innovation Watch. A. Reid, M. Miedzinski, Technopolis and Innovation Watch, 2008

On this basis **The Energy Transition Programme (ETP)** was built, launching a cross-ministerial strategy to boost energy innovation with the aim of building a sustainable energy supply within 2050¹⁰⁴.

The Plan establishes four concrete ambitions for the year 2050:

- More efficient energy use: savings of 1.5-2 per cent per year until 2050;
- Substantial use of green raw materials and renewable energy;
- Reduction of CO2 emissions by half (relative to 1990); and
- Stronger position for the Dutch business community.

The Energy Transition Programme identified seven priority themes for the transition to a sustainable energy system, based on a multi-stakeholder consultation process and on several scenarios. The thematic priorities organised as technical platforms, are the following:

- Sustainable Mobility Platform;
- Biobased Raw Materials Platform;
- New Gas Platform;
- Platform for Chain Efficiency;
- Sustainable Electricity Supply Platform;
- Energy in the Built Environment Platform; and
- The 'Greenhouse as Energy Source' Platform.

For each thematic priority, based on a consensus of representatives from business, academia, NGOs and public government, several development pathways and related experiments were proposed for launching or demonstrating a certain issue.

In 2008 the **Energy Transition Board (ETB)** was established, intended to run for five years, and be the most important, independent, advisory body to help the government implement policies and to achieve a more sustainable energy supply and energy savings. The ETB was initiated at the suggestion of the former Energy Transition Task Force, in order to provide a better continuation of their work. The ETB is supported by six government ministries that also work together in the Interdepartmental Project Management for Energy Transition. The ETB also includes the seventh transition platforms plus other independent members¹⁰⁵.

In 2008, following the implementation of the Energy Transition Programme and its thematic priorities, the government introduced **an Innovation Agenda**¹⁰⁶. In the years 2008-2012 another €438 million is foreseen to be invested on top of the existing innovation budget. The aim is specifically to stimulate the innovation phase after the R&D phase.

The main objective of the innovation agenda is to contribute to:

- the transition to more sustainable energy supplies in the Netherlands;
- 30 per cent less emissions of greenhouse gases in 2020 compared to 1990 levels;
- improved energy efficiency (2 per cent per year);
- realising the renewable target (20 per cent from renewable sources in 2020);

¹⁰⁴ <http://www.senternovem.nl/EnergyTransition/Index.asp>

¹⁰⁵ http://www.senternovem.nl/energytransition/energy_transition_board/index.asp

¹⁰⁶ http://www.senternovem.nl/mmfiles/Energy_per_cent20Innovation_per_cent20Agenda_per_cent20- per cent20Public_per cent20Version_tcm24-282172.pdf

- strengthening the position of the Dutch business community and Dutch knowledge institutes in the world energy market; and
- more innovative entrepreneurs in the energy sector.

The innovation agenda is focusing on the R&D of sustainable techniques and systems and to apply new sustainable energy systems, learning from past experience in order to reduce complexity and costs, and to remove barriers. A main barrier identified for the innovation deployment was a lack of knowledge dissemination and application, which is leading to the disappearance of the R&D. In order to correct it, the innovation agenda aims to further develop the collaboration between key stakeholders viewed as trend-setters in the society.

4.3. SME'S SUPPORT AND TECHNOLOGY TRANSFER

In the Netherlands, support for SMEs is complex: from specific research and pre-commercial programmes to loan guarantee funds, tax facilities, information exchange and international cooperation platforms.

An original policy instrument for stimulating innovation in SMEs is the **Innovation Performance Contract (IPC)**, facilitating the collaboration and the knowledge transfer within a group of companies. The IPC had a €17 million budget in 2007; the SMEs eligible for participation were those belonging to the same supply chain, region, sector, or having in common a specific theme. The IPC programme finances SMEs to start up long-term innovation projects that may also allow for a demand-driven approach. The companies must jointly implement a long-term innovation plan; cooperation and the sharing of knowledge being important aims of the subsidy scheme¹⁰⁷.

Launched as a pilot programme, **Small Business Innovation Research (SBIR)** provides pre-commercial procurement by giving full support for the feasibility and research phase of a project, whilst the intellectual property remains with the company. Many projects financed by SBIR are related to low-carbon and eco innovation, i.e. energy conservation by electromagnetic power, hydrogen and fuel cell systems in civil works etc¹⁰⁸.

The innovative SMEs may receive bank loans for up to 50 per cent of the needs of the project, and up to €1 million, state guaranteed. For start-up companies and innovative companies, larger guarantee possibilities apply. NL Agency¹⁰⁹ acts as a consultant for evaluating the loan application. To date, more than €450 millions have been allocated through this credit line. The European Investment Fund contributes to the funding of the scheme¹¹⁰.

The **TechnoPartner initiative** encourages and supports the start-up of business based on technological inventions. Support is provided by giving techno starters access to capital, knowledge and equipment, as well as by offering them opportunities to exchange questions, comments and ideas.

¹⁰⁷

http://www.senternovem.nl/english/products_services/encouraging_innovation/innovationperformancecontracts_ipc.asp

¹⁰⁸

http://www.senternovem.nl/english/products_services/encouraging_innovation/small_business_innovation_research_sbir_programme.asp

¹⁰⁹ NL Agency came about through a merger of EVD, The Netherlands Patent Office (Octrooi Centrum Nederland) and SenterNovem. Focussing on sustainability, innovation, international business and cooperation, NL Agency is the contact point for businesses, knowledge institutions and government bodies. NL Agency provides one single contact point for information, advice, financing, networking and regulatory matters.

¹¹⁰ http://www.senternovem.nl/english/products_services/encouraging_innovation/sme_loan_guarantees.asp

There are several initiatives to support information exchange and cooperation between innovative SMEs, offering advice, mobility and financial support for joint cooperation at the R&D and pre-commercial stages at the national, EU and international levels. Among them, **Innovation Vouchers** offer a small financial support (a voucher) for SMEs needing the cooperation of a research institute for developing an innovative product¹¹¹.

The Netherlands is very active in international cooperation in the field of low-carbon innovation and has developed agreements with several countries. NL Agency is the main contact point for businesses, knowledge institutions and government bodies, providing information, advice, financing and networking¹¹².

4.4. DEMAND-SIDE POLICY FOR LOW-CARBON INNOVATION

The Netherlands uses various market instruments to foster the deployment of low-carbon technologies. There are feed-in tariffs, tax bonuses and incentives in place to address all the economic sectors, focused on renewable heat and electricity, biofuels, energy savings and support schemes for SMEs. The following table summarises the main low-carbon technology market deployment policies in the Netherlands¹¹³.

Market policy for low-carbon technology	Feed-in tariff/premium	Subsidies/grants/rebates	Investments/tax credits	Energy/sales/excise taxes or VAT reduction	Tradable certificates	Public procurement
	x	x	x	x	x	x

In the Netherlands, there are several schemes to support the deployment of low-carbon innovation, including feed-in tariffs for renewables, funding schemes for green investments, green procurement, tax incentives, eco-driving schemes, energy efficiency schemes and tax benefits.

The Sustainable Public Procurement Programme is designed to encourage government authorities to take heed of environmental and social aspects when procuring products and services. The objectives of the programme are that 100 per cent of government purchases, 75 per cent of municipal authority purchases and 50 per cent of provincial authority purchases be sustainable by 2010. All parties have committed themselves to 100 per cent sustainable purchases by 2015. The 100 per cent sustainable public procurement objective means that the organisation uses the core sustainability criteria in all its tendering and procurement processes and also guarantees that these will be included in the resulting contract¹¹⁴.

The Environmental Quality of Electricity Production Law (MEP – Wet Milieukwaliteit Electriciteitsproductie) established a scheme for subsidising the production of renewable electricity. The government subsidises the additional costs of renewable electricity production compared with conventional electricity (the so-called ‘financial gap’). In 2008, €550 million was paid in MEP subsidies to renewable electricity (excluding subsidies for cogeneration). Due to the growing popularity of the scheme and in order to limit the costs, the scheme was stopped in 2006.

¹¹¹ http://www.senternovem.nl/english/products_services/encouraging_innovation/innovation_vouchers.asp

¹¹² <http://www.senternovem.nl/english/>

¹¹³ Table based on: Renewable 2010. Global status report (REN21)

¹¹⁴ <http://www.senternovem.nl/sustainableprocurement/index.asp>

As a follow-up to the MEP, in 2008 the Ministry of Economic Affairs introduced a new subsidy for renewable energy: the renewable energy stimulation scheme (SDE – stimuleringsregeling duurzame energie). SDE is a feed-in premium scheme for producers, covering extra costs on top of the wholesale energy price for a number of years. The premium is provided to the generator of green power for a maximum of 10-15 years, according to the technology and year of installation. The level of the premium and the duration of support will vary with each technology. However, the premiums will also vary with the wholesale price of electricity. For the **new SDE regulation (Subsidies Duurzame Energie)**, a fund of €300-350 million per year will be available by 2011¹¹⁵. Under the 2009 SDE's scheme, photovoltaic, wind energy (onshore from 2008 and offshore from 2010) and biomass (except for large co-firing of biomass in power plants) are eligible for SDE. Offshore wind has not yet been included because no new permits have been issued. Because of sustainability concerns, liquid biomass fuels are excluded in the first year. Bioenergy producers will possibly be required to report on the sustainability of their biomass. The SDE will be re-evaluated in 2010. In addition, annual expenditures are capped by technology. Estimated yearly caps are calculated based on capacity installed plus estimated installations from 2008 to 2011¹¹⁶. In addition to the feed-in premiums there are other schemes offering tax incentives for investment in renewable energy projects (**The Energy Investment Deduction scheme-EIA**) or for projects aiming to reduce GHG emissions (**CO2 Reduction Plan**, which covers mainly renewable energy projects).

In order to be eligible for using the subsidy schemes, the national and foreign renewable electricity producers must be certified through the **CertiQ** system¹¹⁷. This certificate is necessary to be able to make use of the subsidies for renewable electricity, and it also serves to guarantee the origin to the consumers. The increase in national production of renewable electricity was considerably smaller than the rise in national demand for renewable electricity certificates, thus the imports of renewable electricity certificates rose considerably. It is widely recognised that the increase in demand for renewable electricity in the Netherlands has probably not led to an increase in renewable electricity production in the Netherlands or elsewhere in Europe, but only to an increase in the number of existing installations requesting certificates. Despite these facts, it was agreed that renewable certificates should continue, as they are considered a good instrument for certifying origin and for helping consumers to opt for using green electricity.

A new policy for heating and cooling (aanvalsplan warmte) has been developed in 2008 through consultation with various stakeholders. The overall policy aim is to reduce the demand for heating and cooling, promoting efficient generation of heat and cold and utilising residual heat and cogeneration. Measures that have been taken include financial incentives for the use of heat from renewable sources, residual heat, geothermal heat, stimulating innovations and a national knowledge centre on heat¹¹⁸.

The "More with Less" programme is a joint initiative from the Dutch Government, energy retailers, social housing providers and construction and installation companies. It aims to make 500,000 buildings 30 per cent more energy efficient in the period 2008-2011, increasing to 2.4 million buildings by 2020. "More with Less" attempts to tackle the obstacles to energy conservation within each target group. Energy efficiency measures and programme benefits are provided at periods within the regular renovation cycle (removal and renovation), when people are already inclined to invest. To overcome financial barriers the programme ensures fixed monthly expenses through energy performance contracts.

¹¹⁵ Renewable Energy Policy Review. The Netherlands. Factsheet elaborated in the framework of the EU project: RES 2020: Monitoring and Evaluation of the RES Directives implementation in EU27 and policy recommendations to 2020. EREC 2009

¹¹⁶ <http://www.iea.org/textbase/pm/index.html>

¹¹⁷ Renewable energy in the Netherlands 2008. Statistics Netherlands 2009

¹¹⁸ Renewable Energy Policy Review. The Netherlands. Factsheet elaborated in the framework of the EU project: RES 2020: Monitoring and Evaluation of the RES Directives implementation in EU27 and policy recommendations to 2020. EREC 2009

From 1995, Dutch policy sets energy performance standards for new dwellings and non-residential buildings by means of the so-called **Energy Performance Coefficient (EPC)** which has been sharpened several times. The measures were originally intended to achieve savings of 15-20 per cent in energy consumption. The regulations provide that new buildings must reach a certain energy performance standard. The original standard was set at 1.2, meaning that buildings must be designed in such a way that no more than 1200m³ of natural gas is required annually for heating, hot water and cooking in a standard size dwelling. Renewables in buildings like solar thermal, solar photovoltaics, passive solar and heat pumps contribute to reaching a low energy coefficient. In 2000, the requirements for new residential properties were tightened to 1.0 and in 2006 it was further reduced to 0.8. In 2007, the Dutch Government announced that the energy performance coefficient would be further reduced to 0.6 in 2011 and then to 0.4 in 2015.

Another fiscal instrument in place in the Netherlands is the **energy tax laid on energy consumption of end-users** in order to stimulate rational energy consumption¹¹⁹.

The **Transport Biofuels Act 2007** stipulates that all petrol and diesel producers and suppliers, such as oil companies and traders, are obliged to deliver a certain percentage (in terms of energy value) of their petrol and diesel sales in the Netherlands in the form of biofuels. In 2007 this amount was 2 per cent, rising to 3.25 per cent in 2008. The target for 2009 had been 4.5 per cent, rising to 5.75 per cent in 2010. In 2008, the Act was modified, reducing the 2009 and 2010 targets to 3.75 per cent and 4 per cent respectively, partly to allow the elaboration of rules on the sustainability of biofuels.¹²⁰

The EcoDriving Programme (Het Nieuwe Rijden) aims to increase the passenger vehicle fleet's fuel efficiency by optimising driving behaviour and encouraging a modal shift from passenger vehicles to other forms of transport. The transport efficiency action involves, among the others, fiscal incentives for the purchase of on-board fuel efficiency equipment.

The Netherlands has the second highest level of environmental taxes in the EU after Denmark, at 3.9 per cent of GDP. The Netherlands applies a wide range of green taxes: environmental taxes (taxes on groundwater, tap water, waste materials, fuels and the regulatory energy tax), excise duties on petroleum oils and taxes on vehicles (goods vehicle tax, tax on private cars and motorcycles and tax on heavy goods vehicles). In transport, highly fuel-efficient cars are no longer subject to motor vehicle taxation and, as from 2010, will benefit from a €700 reduction from car purchase tax.

¹¹⁹ <http://international.vrom.nl/pagina.html?id=37448>

¹²⁰ <http://www.iea.org/textbase/pm/index.html>

5. UNITED KINGDOM

5.1. LOW-CARBON INNOVATION CONTEXT

Under its Kyoto Protocol commitments and the European Council's Decision on burden sharing, the United Kingdom must reduce its GHG emissions by 12.5 per cent by 2012 (compared to the baseline). In 1990, United Kingdom was the second main polluter in EU, responsible for some 771.7 million tonnes CO₂ equivalent, and with a significant energy intensive industry and an energy generation sector dominated by oil and coal. In 2008, the United Kingdom already surpassed its Kyoto target, reaching a 19 per cent emission reduction¹²¹, based resulting mainly from a fuel switch, from coal to gas.

Until 2003-2004, the UK was self-sufficient for energy, producing significant quantities of oil, gas and coal. The gradual depletion of oil and gas reserves and a decrease in domestic coal production has led to a growing dependence on imports. However, oil and gas imports were at around 23 per cent in 2009. In the electricity sector, gas has replaced coal as the principal fuel. Fossil fuels (oil, gas and coal) account for 90 per cent of the UK energy mix.

Under the EU renewable energy Directive¹²², the UK has a mandatory target of a 15 per cent share of renewables in the gross energy final consumption by 2020; a great challenge considering that the renewable share was only 2.2 per cent in 2008. In 2009, the renewable electricity share in gross electricity consumption was 6.7 per cent, well below the UK's indicative target of 10 per cent by 2010 as set in the renewable electricity Directive.

The United Kingdom performs well on several innovation performance indicators and has a strong reputation for top-class research and education. UK innovation has good international linkages, ranks first in business enterprise expenditure on R&D funded from abroad, and has well-developed venture capital thanks to a deep financial system. According to the European Innovation Scoreboard (EIS) 2009, the UK is one of the innovation leaders in the EU (fourth, after Sweden, Finland and Germany). Its innovation performance is above the EU-27 average, but the rate of improvement is negative and below that of the EU-27¹²³. In 2007, according to Eurostat¹²⁴, the UK had a 1.79 R&D intensity (R&D expenditure as a percentage of GDP) – below the EU average of 1.85. Around 64 per cent of this funding went to private sector research, 9 per cent to public research and 25 per cent to high education research. The share of the public expenditure on environment and energy R&D is 1.9 per cent and 0.6 per cent respectively (the energy R&D expenditure share on energy is among the lowest in EU)³⁷. Counting the low-carbon patents, the UK is in the world top ten, having a more significant presence in the field of wind, biomass, photovoltaics and concentrated solar power (CSP) technology but being well below the big four (US, JP, DE, CN)¹²⁵. According to a recent report, the UK ranks 9th in the world for sales of clean energy technology and

¹²¹ Annual European Union greenhouse gas inventory 1990–2008 and inventory report 2010. EEA technical report submitted to the UNFCCC Secretariat, 27 May 2010

¹²² DIRECTIVE 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

¹²³ European innovation Scoreboard (EIS) 2009, Comparative analysis of innovation performance, Pro INNO Europe and European Commission Enterprise and Industry, ISBN 978-92-79-14222-2, 2010

¹²⁴ Science, technology and innovation in Europe. 2010 edition. Eurostat

¹²⁵ Who Owns Our Low Carbon Future? Intellectual Property and Energy Technologies. A Chatham House Report, September 2009

only 21st if the sales are weighted by GDP¹²⁶. The report reveals that the strongest clean industry in UK is the one for building insulation, confirming the strong domestic carbon reduction policy for the building sector.

The low-carbon energy installed capacity doesn't represent a significant share in the UK's energy mix and the UK has a laggard position within Europe in building sustainable energy capacity. This slow progress contrasts with that of other EU countries (i.e. Germany, Spain, Denmark) and sits awkwardly with the UK's natural resource potential, particularly in wind (UK is the windiest country in Europe), wave and tidal energy^{127,128}.

However, the UK is the world leader in offshore installed capacity of wind energy and a consistent share of energy production based on biomass. At the end of 2009, the installed capacity of wind power in the UK was over 4GW. Wind power is the second largest source of renewable energy in the UK after biomass. Over 1 GW of new wind power capacity was bought online during 2009 (800MW onshore and 285MW offshore.) The British Wind Energy Association (BWEA) estimates that installed capacity will pass the 6GW mark during 2010.¹²⁹ The UK became the world leader of offshore wind power generation in 2008 when it overtook Denmark¹³⁰ (currently it has 1.04GW of operational capacity and other 1,45GW under construction¹³¹).

Biomass represents some 81 per cent of the UK's renewable energy sector, the main sources being landfill gas (30 per cent), co-firing (12.4 per cent), waste combustion (10.1 per cent), animal and plant biomass (10 per cent), wood (8.6 per cent) and biofuels (7 per cent)¹³².

The solar photovoltaic energy market is moderate to low, with an installed capacity of around 26.5MWp in 2009¹³³.

Latterly, Micro-generation capacities for homes are also particularly encouraged by the state.

The UK is more active in demand side low-carbon policy and measures, all the country's strategy having carbon reduction as a central point. From 1990, the energy intensity decreased in all sectors but energy consumption did not entirely reflect these improvements, being influenced by different causes¹³⁴. However, in 2009 primary energy demand decreased by 6.3 per cent compared to 2008, continuing the last 4 years trend but by a greater amount¹³⁵.

¹²⁶ Clean Economy, Living Planet - Building Strong Clean Energy Technology Industries. Roland Berger Strategy Consultants, study commissioned by WWF Netherlands, November 2009

¹²⁷ <http://www.bwea.com/onshore/index.html>

¹²⁸ Global Trends in Sustainable Energy Investment 2010. Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency. UNEP, SEFI, Bloomberg New Energy Finance, July 2010

¹²⁹ UK Wind Energy Database: <http://www.bwea.com/ukwed/index.asp>

¹³⁰ UK overtakes Denmark as world's biggest offshore wind generator, The Guardian: <http://www.guardian.co.uk/environment/2008/oct/21/windpower-renewableenergy1>

¹³¹ BWEA: offshore wind farms: <http://www.bwea.com/ukwed/offshore.asp>

¹³² Digest of United Kingdom energy statistics (DUKES) 2010: <http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx>

¹³³ Digest of United Kingdom energy statistics (DUKES) 2010: <http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx>

¹³⁴ Energy Efficiency Policies and Measures in the UK 2009. Monitoring of Energy Efficiency in EU 27, orway and Croatia (ODYSSEE-MURE), AEA, 2009

¹³⁵ Digest of United Kingdom energy statistics (DUKES) 2010: <http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx>

5.2. STRATEGIES AND SUPPLY-SIDE POLICY FOR LOW-CARBON INNOVATION

To reach the EU targets and the Member States' ambitious goals, long-term planning and commitments are required in order to offer predictability to the business sector. Up to 2008/2009, the neo-classical economic approach of UK policy was short-run efficiencies of free market provision of goods and services which generated a low interest in energy and innovation policy and its social and cultural dimensions. As a consequence, the R&D budget seriously decreased from the early 1990s and low-carbon innovation and deployment were only modest compared to their potential¹³⁶.

The past year's strategies and policies set some very ambitious targets and seemed to boost the market deployment of low-carbon technology. In the UK it is now widely accepted that innovation is the solution to environmental challenges and the extensive debate has now moved to more practical issues leading to the establishment of numerous bodies and schemes. Based on the 2008 UK Climate Change Act, an independent expert Committee on Climate Change was created to advise the UK Government on setting carbon budgets in order to reach the 2050 target. The Commission on Environmental Markets and Economic Performance (CEMEP) advises on the economic opportunities arising from the transition to a low-carbon, resource-efficient economy¹³⁷.

The Climate Change Act 2008 makes the UK the first country worldwide to have a legally binding, long-term framework to cut carbon emissions. The legally binding targets are a reduction of at least 34 per cent in GHG emissions by 2020 and at least 80 per cent by 2050 (against the 1990 baseline)¹³⁸. The Climate Change Act established a carbon budgeting system which caps emissions over five-year periods and the government must report to Parliament its policies and proposals to meet the budgets. This last requirement was fulfilled in 2009 by the elaboration of the UK Low Carbon Transition Plan. The Climate Change Act also established new powers to support the creation in 2009 of a **Community Energy Savings Programme**, targeted at the residential sector in areas with low income, with the aim to reduce energy bills by improving energy efficiency standards¹³⁹.

In 2009 **the UK Low Carbon Transition Plan (UK LCTP)** was published: a white paper setting the national strategy for climate and energy, which required all UK Government departments to prepare their own plan under a pre-established carbon budget. The UK LCTP set a target of 30 per cent renewable energy production by 2020, aiming to facilitate green investments for residential energy savings, introducing clean energy cash-back schemes and supporting the development and use of clean technologies. The UK LCTP announces a longer term roadmap for the transition to a low carbon society for the period 2020 -2050 and a vision for a smart grid. The UK LCTP foresees support for low-carbon innovation and set zero-carbon targets for new public buildings by 2016 and 2018¹⁴⁰.

¹³⁶ Dynamics and deliberations: comparing heuristics for low carbon innovation policy. SPRU Electronic Working Paper Number 184. J. I. Scrase, A. Smith, F. Kern, March 2010

¹³⁷ Innovation, climate change and a more resource efficient economy, Policy Brief No4 (2010) A. Karakasidou & P. Cunningham, Manchester Institute of Innovation Research, University of Manchester, January 2010

¹³⁸ <http://www.defra.gov.uk/environment/climate/legislation/index.htm>

¹³⁹ http://www.decc.gov.uk/en/content/cms/what_we_do/consumers/saving_energy/cesp/cesp.aspx

¹⁴⁰ The UK Low Carbon Transition Plan. National strategy for climate and energy. Presented to Parliament pursuant to Sections 12 and 14 of the Climate Change Act 2008, Amended 20th July 2009 from the version laid before Parliament on 15th July 2009.

The **UK Low Carbon Industrial Strategy (UK LCIS)**¹⁴¹, published in parallel with the UK LCTP, sets out the scale of potential business opportunities and a programme of government action. The strategy aims to support business by providing targeted support for innovation and investment in the UK and by developing the skills needed for a low carbon economy. The UK LCIS foresees targeted support for innovation and investments in:

- offshore wind (£120 million);
- wave and tidal energy (£60 million, plus £22 million grant funding through marine renewable proving fund for testing and demo-projects);
- ultra-low carbon vehicles (£10 million for electric vehicles plus £20 million for infrastructure, £140 million for research, development and demonstration under the Technology Strategy Board's Low Carbon Vehicle Innovation Platform, plus £230 million for consumer incentives);
- smart grids (£6 million for early stage development of trials of key technologies); and
- low-carbon buildings (£6 million for 60 more low carbon homes with innovative and renewable materials).

Alongside the UK LCTP and UK LCIS, the **UK Renewable Energy Strategy**¹⁴² and the **Carbon Reduction Strategy for Transport** were published¹⁴³. Together these set out the policies with which to drive the transition to decarbonising the economy.

The UK Renewable Energy Strategy 2009¹⁴⁴ outlines how the UK will meet its legally-binding target to ensure 15 per cent of energy comes from renewable sources by 2020. The Strategy supports the EU renewable energy Directive and comprises three primary 2020 targets:

- Over 30 per cent of electricity to be generated from renewable energy sources, mostly from wind power, with biomass, hydro, wave and tidal power playing important roles;
- 12 per cent of heat to be generated from renewable energy sources, from a large range of sources (biomass, biogas, solar, heat pumps); and
- 10 per cent of transport energy to come from renewable energy sources.

The key measures to achieve the targets are:

- An expansion and extension of the Renewables Obligation, requiring energy suppliers to sell larger amounts of renewable energy. New measures to increase financial support for offshore wind will also be considered.
- Introducing payment schemes to support the production of renewable heat and small-scale clean electricity generation by households, industry, businesses and communities. New guaranteed payments will be provided through feed-in tariff schemes from 2010 onwards, and a Renewable Heat Incentive from 2011 onwards. Before the schemes take effect, £45 million in grants have been committed¹⁴⁵.

¹⁴¹ The UK Low Carbon Industrial Strategy, the Department for Business, Innovation and Skills and the Department for Climate Change and Energy, 2009

¹⁴² HMG (2009) The UK Renewable Energy Strategy, www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx

¹⁴³ DfT (2009) The Carbon Reduction Strategy for Transport, www.dft.gov.uk/carbonreduction

¹⁴⁴ http://www.decc.gov.uk/en/content/cms/what_we_do/uk_supply/energy_mix/renewable/res/res.aspx

¹⁴⁵ On 1st February 2010, DECC published a consultation on the proposed design of the Renewable Heat Incentive scheme. Following the February consultation and in light of the 2010 Spending Review announcement, DECC will consider further the operation of the scheme including RHI tariffs and technologies supported. More info on <http://decc.gov.uk/>

- The Renewable Transport Fuel Obligation will be amended or replaced, taking into account sustainability issues, to ensure transport fuels contain a rising amount of renewable biofuels.
- The Strategy also creates an Office for Renewable Energy Deployment (ORED) within the Department of Energy & Climate Change (DECC) to take forward the commitments outlined in the Strategy.

In addition, the Strategy sets out areas for action aiming to make planning processes swifter and more strategic, to set additional measures strengthening the UK's renewable energy industry, to foster improvements and investments in the electricity grid and commitments for sustainable bioenergy development and use. The Strategy also commits to using part of £405 million funding for key emerging technologies for renewable energy technologies, such as wave and tidal generation, offshore wind, and advanced biofuels.

The 2007 **Low Carbon Transport Innovation Strategy (LCTIS)**¹⁴⁶ sets out a wide range of actions that the UK is taking to encourage innovation and technology development in lower carbon transport technologies. A key role for government will be to stimulate investment in a broad range of R&D activities, including short term and long term options. Essential to this will be the use of regulatory frameworks such as carbon pricing and energy efficiency, but also government funding aimed at accelerating the development and market penetration of new lower carbon technologies. To stimulate this shift towards low-carbon transportation technologies, one major initiative is **the Low Carbon Vehicles Innovation Platform (LCVIP)**, a £100 million programme over 5 years.

For accelerating the development and deployment of low carbon technologies **The Low Carbon Innovation Group (LCIG)** was created, consisting of the UK's three main independent, publicly-backed energy innovation organisations - the Energy Technologies Institute (ETI), the Technology Strategy Board (TSB) and the Carbon Trust.

The Energy Technologies Institute (ETI)¹⁴⁷ is an innovative Limited Liability Partnership between international energy related industrial companies and the UK Government. The ETI bridges the gulf between laboratory proven technologies and full scale commercially tested systems, acting worldwide with the aim to take the most challenging large-scale energy projects to full system demonstration, lowering the risk of future development. The ETI aims to overcome major barriers to the deployment of low-carbon energy developing a focused portfolio of projects in areas such as wind, marine, distributed energy, and transport. Due to the high potential impact of carbon capture and storage (CCS) technologies, recently they have also been added to the portfolio.

The Technology Strategy Board¹⁴⁸ aims to stimulate innovation in areas offering the greatest scope for boosting growth and productivity. The TSB works on the basis on the 2008 Strategic Plan: "Connect and Catalyse - a strategy for business innovation" and has an overall budget of more than £1 billion for the period 2008-2011. TSB's application areas are broad fields where technological innovation has a major role to play and which represent major societal challenges. These application areas currently include several topics addressing low-carbon innovation:

¹⁴⁶ <http://www.dft.gov.uk/pgr/scienceresearch/technology/lctis/lowcarbontis>

¹⁴⁷ <http://www.energytechnologies.co.uk/Home/aboutus.aspx>

¹⁴⁸ <http://www.innovateuk.org/>

- Environmental sustainability (including resource efficiency, waste and pollution management, energy efficiency, water supply);
- Energy generation and supply (including low carbon energy technology investments with a portfolio of £153 million (including private capital), innovative technology solutions on fuel cells and hydrogen, carbon abatement technology and marine technology-the last together with The Carbon Trust, the Energy Technologies Institute and DECC);
- Transport (with the aim to stimulate innovation at all stages of the supply chain to intelligently deliver more efficient, cleaner and safer transport.)
- Built environment (with the aim to increasing the exploitation of innovation in the built environment)
- Knowledge Transfer Networks for energy generation and supply, transport, modern built environment and environmental sustainability;

The TSB has seven innovation platforms, of which three address low-carbon innovation:

- Intelligent Transport Systems and Services;
- Low Carbon Vehicles; and
- Low Impact Buildings.

The Carbon Trust¹⁴⁹ works with research institutions and industry to support innovative low-carbon technologies, working on complementary issues with the ETI, which focuses on energy research and international collaboration. Carbon Trust support for low-carbon technology is managed through the Technology Accelerators (technology platforms) with the aim of opening markets for low carbon technologies and through Research Challenges that are about commercialising promising technologies which have not yet entered the market.

5.3. SME'S SUPPORT AND TECHNOLOGY TRANSFER

The UK innovation system has an important regional component, based on the fact that as the production of new knowledge and technology becomes more global, different regions and places within the UK will innovate in different ways. The Regional Development Agencies (RDAs) have several main products to support business innovation and SMEs:

- Networking for Innovation;
- Innovation Vouchers;
- Collaborative Research and Development;
- Grant for Research and Development;
- Innovation Advice and Guidance; and
- Designing Demand.

However, the White Paper on Local Growth¹⁵⁰ published by the UK Government in October 2010 announced significant reform of the local development policy, introducing new measures that complement other changes the Government is taking to drive growth, through investment, support for education and skills, improvements in competition, and support for research and innovation. As part of this deep transformation, the RDAs will be abolished by March 2012 being gradually replaced by the Local Enterprise Partnerships (LEPs). Some of the RDAs' current functions may continue at a national, rather than local

¹⁴⁹ <http://www.carbontrust.co.uk/Pages/Default.aspx>

¹⁵⁰ <http://www.bis.gov.uk/news/topstories/2010/Oct/local-growth>

level. So far, the innovation vouchers scheme was stopped¹⁵¹ and the grants for research and development as well as the innovation advice and guidance scheme are likely to migrate to TSB.

‘Building Britain’s Future: New Industry, New Jobs’¹⁵², the UK’s recovery strategy from 2009, had climate change challenge and the new low-carbon technology in the core part of the future strategy in market transformation and for recovery the UK economy after the financial crisis. The strategy set up the **UK Innovation Investment Fund** (UK IIF) for investment in technology-based businesses with high growth potential, including low carbon. The UK IIF is focused on investing in growing SMEs, start ups and spin outs, in digital and life sciences, clean technology and advanced manufacturing. The Fund has £125 million to invest in clean technology.

In the 2008 **‘Innovation nation’ White Paper** a range of initiatives are set out, intended to help SMEs to link up with universities and colleges for developing new products and services. The strategy addresses some of the themes raised by the 2007 review of the government's science and innovation, when some weaknesses of the British innovation system were revealed, such as the low rate of business start-up and SMEs growth and a relative lack of skills, tailored incentives and promotion of good practice. The key features of the Innovation Nation included:

- At least 1,000 innovation vouchers every year by 2011 to support SMEs businesses to work with a university, further education college or research organisation of their choice;
- Doubling the number of knowledge transfer partnerships between businesses, universities and colleges;
- Piloting a new specialisation and innovation fund to boost the capacity of further education colleges to unlock workforce talent and support businesses; and
- Expanding the network of national skills academies.

As part of its international cooperation, a series of Sustainable Development Dialogues are now underway with China, India, Brazil, South Africa and Mexico, with the aim of mutual learning on how to incorporate sustainable development values into government policy. The Dialogues are a cross-government initiative with the aim to contribute to the UK's 2005 Sustainable Development Strategy priorities on climate change and energy; sustainable consumption and production; natural resource management; and building sustainable communities.

5.4. DEMAND-SIDE POLICY FOR LOW-CARBON INNOVATION

For fostering the deployment of low-carbon innovation, the UK has established a complex set of regulatory measures, addressing all the economic sectors and using various market instruments as feed-in tariffs for renewables, energy savings trading schemes (white certificates), subsidies, tax exemption or levies, financial support through grants and state-guaranteed preferential credits. The market deployment of low-carbon technology is supported by several tax exemptions, such as: stamp duty exemption for new zero-carbon homes, exemption from the climate change levy for renewable electricity, exemption from income tax for electricity surplus sold by individual households, and reduced VAT for the professional installation of micro-generation equipment in residential and charitable properties.

¹⁵¹ <http://www.businesslink.gov.uk/bdotg/action/detail?itemId=5001241747&type=CAMPAIGN>

¹⁵² HMG (2009) Building Britain’s Future: New Industry, New Jobs, www.berr.gov.uk/files/file51023.pdf

UK policy was very effective in attracting private venture capital in the early-stages of innovation, with around €620.2 million of private investment in high-tech industries and knowledge-based services in 2007¹⁵³. However, despite a strong legal and institutional framework as well as high ambition, low-carbon innovation seems to be under-financed and less attractive to private capital. The lack of long-term predictability in policy was another main barrier to low-carbon innovation deployment in UK.

The main low-carbon legislation is the **Energy Act 2008** and the **Climate Change Act 2008**. On April 2010 the Energy Bill received Royal Assent, becoming the Energy Act 2010. The Act includes provisions on introducing a new CCS incentive, the introduction of a mandatory social price support and calls for fair access to energy markets. However, in May 2010 the new coalition government announced that a new Energy Bill will be proposed shortly.

The following table summarises the main low-carbon technology market deployment policies in the UK¹⁵⁴.

Market policy for low-carbon technology	Feed-in tariff/premium	Subsidies / grants/rebates	Renewable portfolio/quotas	Energy/sales/excise taxes or VAT reduction	Tradable certificates	Public investments, loans or financing	Public procurement
	x	x	x	x	x	x	x

All government departments had to develop innovative **Procurement Plans** by the end of 2009. The Technology Strategy Board takes an advisory role on public procurement to promote innovation in construction and waste management. In addition, the Low Carbon Transport Innovation Strategy and the Department for Transport (DfT) **Low Carbon Vehicle Procurement programme** aim to use public sector purchasing power to accelerate the market introduction of lower carbon vehicle technologies.

In order to bring forward the development of new low-carbon energy and energy efficiency technologies in the UK, the **Environmental Transformation Fund (ETF)**¹⁵⁵ it was launched in 2008, jointly administrated by Defra and the Department for Business, Innovation and Skills (BIS). The ETF has both national and international elements. Funds within the UK element of the Fund total £400 million during the period 2008/09 to 2010/11. The UK element of the Fund aims to accelerate the commercialisation of low-carbon energy and energy efficiency technologies in the UK. The fund is specifically focus on the demonstration and deployment phases of bringing low-carbon technologies to market. The total value of the ETF budget is around £1.2 billion over a three year period, including an £800 million international element focused on poverty reduction, environmental protection and to help developing countries to tackle climate change. The ETF finances schemes operated by other bodies like the Carbon Trust and BIS, bringing the low-carbon technology funding programmes, as follows:

- Hydrogen Fuel Cell and Carbon Abatement Demonstration Programme;
- Marine Renewables Deployment Fund;
- Low Carbon Buildings Programmes;

¹⁵³ Science, technology and innovation in Europe. 2010 edition. Eurostat

¹⁵⁴ Table based on: Renewable 2010. Global status report (REN21)

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<http://webarchive.nationalarchives.gov.uk/+http://www.berr.gov.uk/whatwedo/energy/environment/etf/page41652.html>

- Bio-energy Capital Grants and Bio-energy Infrastructure Schemes;
- Offshore Wind Capital Grants programme;
- Carbon Trust's innovation programme, including research accelerators, technology accelerators, and incubators;
- Carbon Trust funding for new low-carbon technology enterprises, including Partnership for Renewables;
- Carbon Trust investments in low-carbon technology businesses;
- Carbon Trust energy efficiency loans scheme for small and medium sized enterprises (SMEs); and
- Salix Finance public sector invest-to-save loan schemes.

For financing the electricity distributors to invest in new technologies and addressing the investment barriers, the Network Innovation Fund announced in 2009 by OFGEM (Office of Gas and Electricity markets) established a £500 million portfolio over the next five years¹⁵⁶.

Trying to boost low-carbon technology deployment by offering the necessary financing, the new UK Government (a conservative-liberal coalition, in-power from May 2010) announced the idea of establishing a **Green Investment Bank**. As part of the creation of this bank, the government intends to create financial products to provide investment opportunities for the infrastructure needed to support the new green economy.

The deployment of biomass fuelled heat projects in the UK is also supported by the £66 million **Bioenergy Capital Grants scheme**. Support is targeted to four areas, including small and medium scale CHPs¹⁵⁷.

The Renewables Obligations (RO) is a green certificates scheme to foster the generation of electricity from eligible renewable sources in the United Kingdom¹⁵⁸. The RO places an obligation on licensed electricity suppliers in the UK to source an increasing proportion of electricity from renewable sources (similar to a renewable portfolio standard). Also encouraging were the developments on policy. The UK Government introduced banding to its RO scheme in April 2009, offering bigger support to offshore wind, marine (wave and tidal) energy, dedicated energy crops, advanced gasification and anaerobic digestion. More mature low-carbon technologies such as onshore wind and landfill and sewage gas will receive fewer certificates. The RO certificates may be sold by generators directly to licensed electricity suppliers or traders but can also be traded separately from the electricity to which they relate. The current obligation amounts to 15 per cent of electricity supply in 2020. So far, the RO system has under-achieved in relation to its quantitative target, mainly given the low buy-out price: in 2007, 4.9 per cent (15.9 TWh) was supplied which should be compared with the target of 7.9 per cent (or 25.6 TWh). Wind power is the dominant renewable electricity technology benefited by RO¹⁵⁹.

The Renewable Transport Fuel Obligation (RTFO) places an obligation on fuel suppliers to ensure that a certain percentage of their aggregate sales is made up of biofuels. The effect of this will be to require 5 per cent of all UK fuel sold on UK forecourts to come from a renewable source by 2010. These targets have been set on a volume basis. The RTFO is modelled on the existing Renewables Obligation in the UK

¹⁵⁶ 'Eco-innovation in industry. Enabling the green growth', ISBN: 978-92-64-07722-5, OECD 2009

¹⁵⁷ Renewable Energy Policy Review: United Kingdom. Factsheet elaborated in the framework of the EU project: RES 2020: Monitoring and Evaluation of the RES Directives implementation in EU27 and policy recommendations to 2020. EREC 2009

¹⁵⁸ Digest of United Kingdom energy statistics (DUKES) 2010:

<http://www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx>

¹⁵⁹ EU renewable energy support policy: Faith or facts? S. Jacobsson, A. Bergek, D. Finon, V. Lauber, C. Mitchell, D. Toke, A. Verbruggen, Energy Policy 37 (2009) 2143–2146

electricity supply industry and can be traded in order to fulfil the obligations. Sustainability requirements were added in 2007. In 2009 the short term targets for the RTFO were reduced, thereafter rising in annual increments of 0.5 per cent to 5 per cent¹⁶⁰.

Feed in tariffs (FITs) are a financial support scheme for eligible low-carbon electricity technologies, aimed at small-scale installations up to a maximum capacity of 5MW. FITs vary according to technology, will last between 10 to 25 years, and are adjusted for inflation. They apply to hydropower, new anaerobic digestion, wind and solar photovoltaic technologies up to 5MW. A pilot scheme for micro CHP (up to 2kW electrical capacity) has also been launched¹⁶¹. **Micro-generation technologies** were seen as having considerable potential by the UK Government. Micro-generation involves the local production of electricity by homes and businesses from low-energy sources including small scale wind turbines, ground source heat pumps and solar electricity installations. As of April 2010, feed-in tariffs (called "Clean Energy Cash-back") are being introduced to support micro-generation¹⁶².

On energy efficiency measures, the UK has in place from 2002 a white certificate scheme¹⁶³: **the Carbon Emission Reduction Target (CERT, formerly the Energy Efficiency Commitment)**¹⁶⁴, which imposes an energy saving target on gas and electricity transporters and suppliers of energy supplied to the residential sector. CERT will maintain a focus on vulnerable consumers and will include new approaches to innovation and flexibility.

The Community Energy Savings Programme is intended to support new and existing partnerships of local councils, voluntary organisations and energy suppliers to offer free and discounted central heating, energy efficiency measures and benefit checks. This programme will be funded through a new and additional obligation on the energy suppliers and electricity generators. Around £350 million will be spent by energy companies over the next three years to deliver whole-house and whole-street energy efficiency retrofits, focusing on some of the most vulnerable areas in the UK. The **Energy Saving Trust (EST)** was created to provide free information and advices for companies and consumers to enable them to take action on energy saving. The EST has an extensive network of local advice centres distributed all over the country.

Targeting large private and public sector organisations, **the Carbon Reduction Commitment Energy Efficiency Scheme (CRC)** is a mandatory scheme aiming to improve energy efficiency, reduce GHG emissions, and help large public and private organisations to generate cost savings through reduced energy expenditure. The scheme provides a financial incentive to reduce energy use and places a cap on carbon emissions of the participating organisations. Under the CRC, organisations must buy allowances equal to their annual emissions. The overall emissions reductions achieved by the scheme will be determined by the emissions 'cap' on the total allowances available to CRC participants. Within the overall limit, the organisations can determine the most cost-effective way to reduce their emissions through buying extra allowances or investing in ways to decrease the number of allowances they need to buy. Together with the financial and reputational considerations, the scheme also encourages organisations to develop energy

¹⁶⁰ Renewable Energy Policy Review: United Kingdom. Factsheet elaborated in the framework of the EU project: RES 2020: Monitoring and Evaluation of the RES Directives implementation in EU27 and policy recommendations to 2020. EREC 2009

¹⁶¹ <http://www.iea.org/textbase/pm/?mode=cc&action=result>

¹⁶² Energy in the united Kingdom: http://en.wikipedia.org/wiki/Energy_in_the_United_Kingdom#Renewable_energy

¹⁶³ Tradable certificates for energy savings

¹⁶⁴ The Energy Efficiency Commitment 1 (2002-2005) program required that all electricity and gas suppliers with 15,000 or more domestic customers must achieve a combined energy saving of 62 TWh by 2005 by assisting their customers to take energy-efficiency measures in their homes: suppliers had to achieve at least half of their energy savings in households on income-related benefits and tax credits. In the Energy Efficiency Commitment II (2005-2008), energy saving targets were raised to 130 TWh. The third phase of CERT runs from 2008 to 2011 and increased the previous targets to 154 MtC. The UK Government proposed in 2009 that the targets for 2011 be increased by a further 20 per cent to 185 MtC.

management strategies that promote a better understanding of energy usage. All UK Government departments are required to register as participants in the scheme. Qualifying organisations will have to comply legally with the scheme or face financial and other penalties.

As part of the UK's Low Carbon Transition Plan, the household and buildings sector will need to achieve near-zero carbon emissions by 2050. The UK Government has identified the lack of upfront finance as an important barrier to achieving building sector goals, and is piloting a **Pay-As-You-Save (PAYS)** financing approach to assess consumer preferences and interest, as well as the practicalities of such a scheme. Under PAYS, the up-front costs of carrying out an energy efficiency retrofit are met by a third party and are then repaid by the householder from money saved on energy bills (energy performance contracting), generally through long repayment periods (up to 25 years).