Answers to Questionnaire for the IEA/SLT/CERT 2012 In-Depth Review of the Energy Policy of Sweden

Key recommendations from previous IDR

The Government of Sweden should:

- ***Clarify the conditions for the use of existing and future nuclear power capacity, with due consideration to electricity prices, climate change mitigation and security of energy supply.***

In 2010 the Parliament approved two bills which meant a considerable change as compared to previous years' policy regarding nuclear power, i.e.:

- It will be possible to replace old reactors with new ones, given that the old one is permanently closed and the new reactor is situated on the same locations as the old one.
- Nuclear power industry was given unlimited financial liability in the case of a serious accident.
- Nuclear industry will have to carry all the costs associated with nuclear power, i.e. there will not be any form of direct nor indirect public subsidy
- The policy leaves it up to the power industry to decide whether it is commercially interesting to invest in new reactors, given that nuclear industry will not receive any form of, subsidy whereas renewable energy will be continuously supported.

- ***Continue efforts to reduce oil use in the transport sector, especially by encouraging more efficient fuel use and by promoting alternatives to oil based road transport, including transport of freight.***

The measures described under section 4 B and in particular 4 G aim at reducing the oil use in the transport sector. More efficient fuel use and alternative fuels is promoted by a number of fiscal incentives but also by research and development. As a result the energy use in the transport sector has decreased between 2010 and 2011 and the share of renewable fuels in road transport has increased to 6.8 percent in 2011.

- ***Focus efforts to increase the supply of renewable energy on sources that are deemed the most sustainable, based on an evaluation of their economic, environmental and social benefits.***

The new comprehensive climate and energy policy that was adopted in 2008 includes two targets for renewable energy: A total share of at least 50% by 2020 and a share of at least 10% in the transport sector. The actual developments since then as well as projections for 2020 shows that Sweden is well on track to reach

those goals. In 2010 the overall share was 47,8% and in 2011 the share in the transport sector was 9,8% (EU RES Directive reporting methodology). Projections show a total share of renewable energy of 50,2% by 2020 and a share in the transport sector of 13,8%.

The technology neutral market based electricity certificate scheme is a key tool to increase the share of renewable energy. It has been further developed including increasing the target to 25 TWh new RES electricity by 2020 from 2002 and prolonging the system to 2035. From 1 january 2012 Sweden also has a joint certificate market with Norway, increasing the cost-effectiveness further.

The environmental impact of new installations are considered in the environmental permitting process. One example of a supporting effort is "Vindval", a research programme focused on actual environmental impacts from new wind power plants, the results of which are used frequently by project owners and courts deciding on the environmental permits.

The government has phased out some (to the certificate scheme) additional support to renewable energy including investment aid to existing technologies and the "environmental bonus" for wind power, instead strengthening the measures for the development of new technology. R&D includes support to the demonstration of the production of second generation biofuels that have multiple benefits (including ecological and economical) over first generation biofuels.

Content

1. General Energy Policy

1-A Outline of key energy policies including major changes since previous IDR

Elections were held in September 2010 which resulted in a minority government comprising the same four parties as for the previous term of office: the Liberal Party; the Centre Party; the Christian Democrat Party and The Moderate Party.

In 2009, the Parliament approved a new comprehensive climate and energy policy on the basis of the Government Bills 2008/09:162 and 2008/09:163, under the common name of "A joint climate and energy policy". The new climate and energy policy, which is based on the EU's 20/20/20 targets, sets a number of targets and for Sweden:

By 2020:

- 40 per cent reduction in greenhouse gases compared to 1990
- At least 50 per cent share of renewable energy in the energy mix
- At least 10 per cent share of renewable energy in the transport sector
- 20 per cent more efficient use of energy compared to 2008

Long-term priorities and vision beyond 2020:

- By 2030, Sweden should have a vehicle stock that is independent of fossil fuels.
- Sweden's electricity production today is essentially based on only two sources – hydropower and nuclear power. To reduce vulnerability and increase security of electricity supply, a third pillar that reduces dependence on nuclear power and hydropower should be developed. To achieve this, cogeneration, wind power and other renewable power production must together account for a significant proportion of electricity production.
- A vision that, by 2050, Sweden will have a sustainable and resource-efficient energy supply and no net emissions of greenhouse gases in the atmosphere

References: http://www.sweden.gov.se/content/1/c6/12/00/88/d353dca5.pdf

http://www.regeringen.se/content/1/c6/12/27/85/65e0c6f1.pdf

http://www.regeringen.se/content/1/c6/12/27/78/4ce86514.pdf

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In 2010, the Parliament approved two bills which meant a considerable change as compared to previous years' policy regarding nuclear power. The decision means it will be possible to replace old reactors with new ones, given that the old one is permanently closed and the new reactor is situated on the same locations as the old one. The industry itself now can decide which production technology it wish to employ, given the commercial conditions that follows from a policy which does not allow any form of subsidy to nuclear power and focus its support on renewable energy. The legislation entered into force 1 January 2011.

References: http://www.regeringen.se/content/1/c6/14/23/59/12af3725.pdf

http://www.regeringen.se/content/1/c6/14/23/62/a46f3e48.pdf

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Progress since previous IDR toward low-carbon energy sector: low-carbon energy supply and efficient use of energy

In 1990, Sweden's proportion of renewable energy amounted to 33%. By 2010, it had increased to 47,8%. Of the total renewable energy in 2009 (187 TWh) renewable electricity production and the industrial use of biofuels constituted the largest items. Of the total use of renewable energy, biofuels accounted for 57%. The increase in the proportion of renewable energy since the 1990s is due in large part to the use of biofuels in electricity and heat production and in the forest industry. Renewable energy in the transport sector accounts for a small part of the total use of renewable energy.

The heating sector in Sweden - to a large extent district heating – is today practically fossil fuel free as a result of the increased use of biomass and heat pumps. The same is true for the electricity sector, where hydro power and nuclear stands for the main part of the production and wind power is increasing rapidly.

Policies of Security of Supply

The Swedish Government states that Swedish energy policy should be based on the same foundations as the wider energy cooperation in the EU i.e. ecological sustainability, competitiveness and security of supply. Several energy policies are in place contribute to multiple objectives including security of supply. Some examples are policies to increase the share or renewable energy (such as the electricity certificate scheme) and policies to promote energy efficiency and R&D efforts to develop more effective energy technologies.

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1-B Previous IDR recommendations

The government of Sweden should:

- *Prepare a comprehensive energy and climate strategy for the medium and long term, including a clear role for the future use of nuclear energy.*

Action taken:

In 2009 the parliament approved the government's proposal for a new comprehensive energy and climate strategy for the medium and long term which also includes clear rules for the future use of nuclear energy. For further information see section 1-A.

- *Streamline and significantly shorten the approval and licensing process for electricity generation, gas supply and energy infrastructure projects.*

Action taken:

August 1 2009, a new third paragraph in Chapter 2. 8 a § Electricity Act came into force. The addition means that issues that are proven in a case or matter concerning approval of a construction need not to be re-examined in the case of grid license. If, in the case or matter for a permit under the Environmental Code contains an environmental impact assessment that describes the direct and indirect effects on human health and the environment that the line can bring, there need to be no specific environmental impact assessment in the grid license matter. This means that some issues relating to environmental impact assessment are only examined once by the county administrative board rather than, as before, by both the Energy Markets Inspectorate and the county administrative board.

Pursuant to Chapter 2. § 4 first paragraph of the Electricity Act, the Government may provide for an exemption from the requirement for grid license for certain types of lines or in the case of lines in certain areas. 22 a § and 30 § of the Ordinance (2007:215) for exemption from the requirement for network license under the Electricity Act (1997:857), states that two or more plants which form a functional unit may be connected to internal networks without requirement of a network license. The provision came into force on January 1 2009. Energy Markets Inspectorate has left around ten binding statements for internal networks linking production sites.

Several efforts are in place to support the permitting procedure of wind power plants including financial support to municipalities that wish to include wind power in their spatial planning, financial support to County Administrative Boards to handle applications for permits for new wind power projects and "vindval", a research programme about environmental impacts of new establishments resulting in information that could be used by project owners and courts in their handling of permit applications. See national renewable action plan and first progress report to the EU-commission for more info (links in section 4).

- *Review, with the aim of simplifying, the energy-related tax structure.*

Action taken:

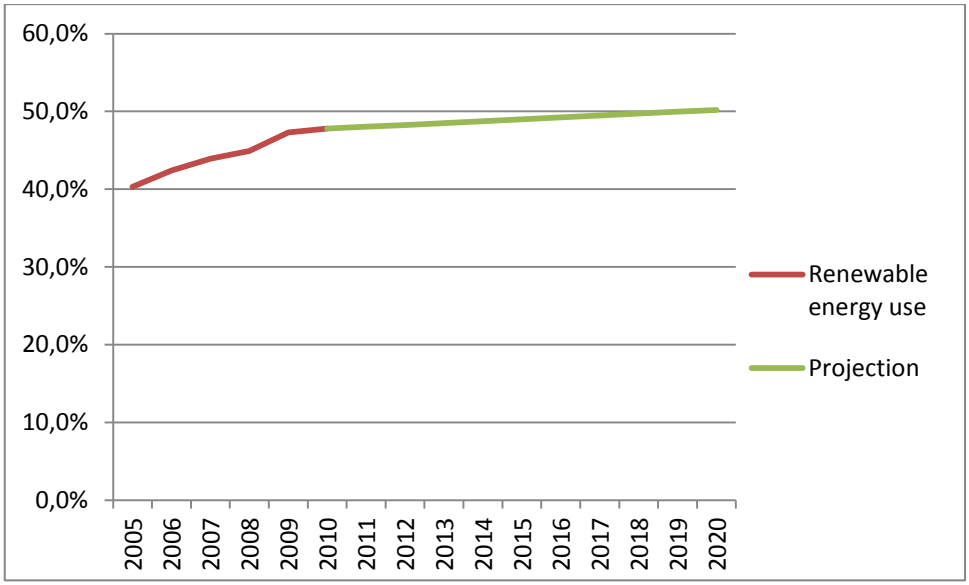
Various changes in the taxation system have been made in accordance with the Government Bill 2009/10:41 with the purpose of achieving more efficient energy use by reducing the number of exemptions through tax increases on both energy and carbon dioxide tax. For further information see section 1 E.

1-C Notable Changes in Indicators

Renewable energy

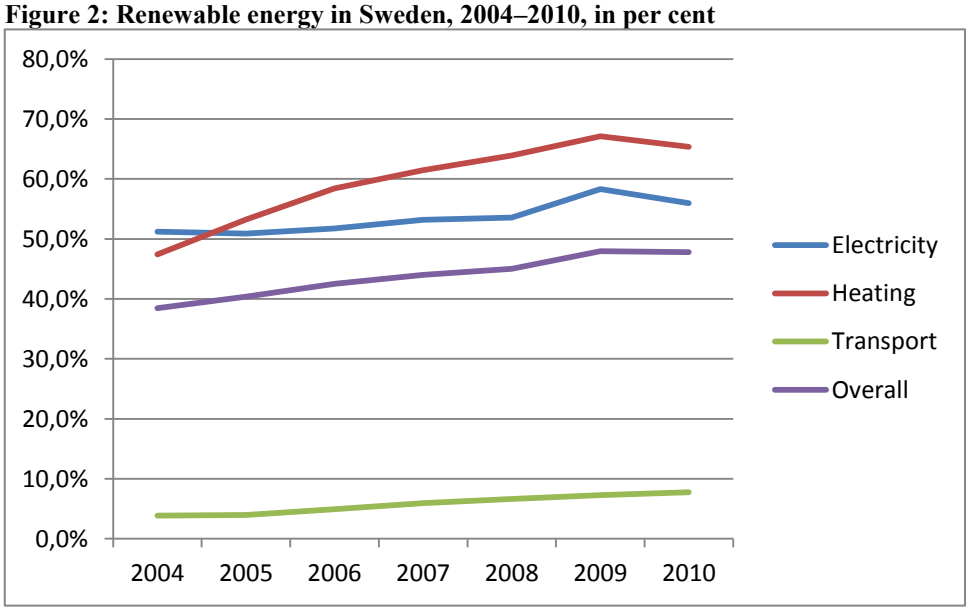
By 2010, the share of renewable energy had increased to 47.8%, the target being 50 % in 2020. The target will be met according to the projection in figure 1. The increase from 2004, the share then being 38 %, is due to an increase in the use of renewable energy as well as a decrease of the total energy use. The total energy balance can be seen in a table 2 in section 1F.

Figure 1: Renewable energy use, 2005–2010 and projection 2011-2020, in per cent



The development of the shares of renewable energy for heating and cooling, electricity and transport can be seen in figure 2.

Figure 2: Renewable energy in Sweden, 2004–2010, in per cent



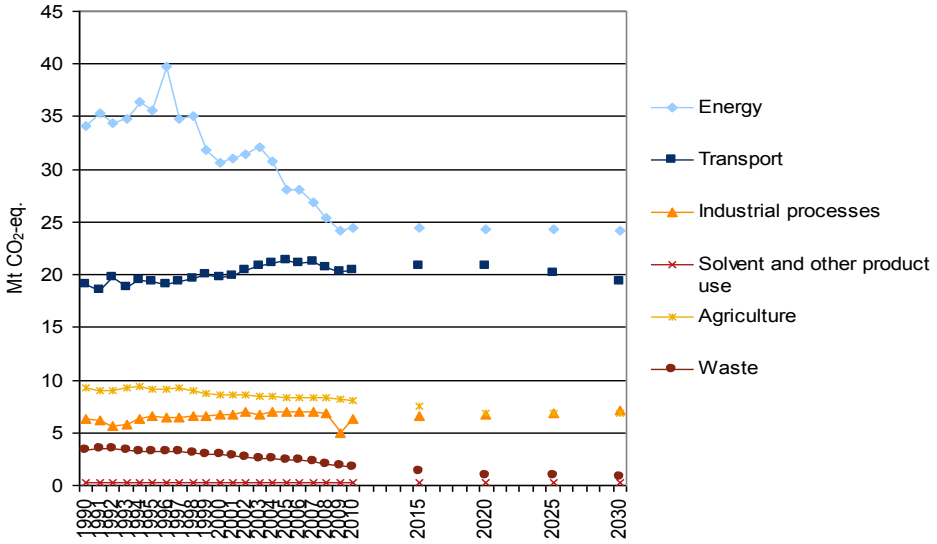
For more information see chapter 4 on renewable energy.

Greenhouse gas emissions

The projected trend in emissions differs between different sectors of society. The energy sector, excluding transport, is expected to reduce its greenhouse gas emissions between 1990 and 2020 by 29 %, while the transport sector is expected to increase its emissions by 9 %. Emissions from the agricultural sector have

decreased to date and are expected to continue to decrease to be 26 % below the 1990 level in 2020. Emissions from the waste sector are expected to be halved in 2010 in comparison with 1990 and 71 % below the 1990 level in 2020. The emissions from industrial processes including fluorinated greenhouse gases are estimated to increase between 2009 and 2020. In 2020 the total emissions from industrial processes are estimated to be 6 % higher than the 1990 level.

Figure 3: Historical and projected emissions of greenhouse gases from different sectors 1990–2030, in million tonnes CO2-equivalents



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1-D Institutional overview

Sweden has a four party minority Government with implementing national authorities and active local authorities. The development of energy policy rests with the Central Government.

Ministries

- Näringsdepartementet, Ministry of Enterprise, Energy and Communications

The Division for Energy has an overall co-ordination and planning role for Swedish energy policy. This division has a staff of around 25 people.

- Miljödepartementet, Ministry of the Environment.

The Division for Climate is responsible for Sweden's participation in global climate change negotiations and the EU's work on fulfilling its commitments under the Kyoto Protocol. In addition, the Division is responsible for emissions trading, project-based mechanisms and other climate policy instruments, and air quality issues. The Division also works to promote a green economy within the framework of sustainable development, the use of environmental technologies, and regional environmental cooperation in the Nordic and Arctic regions and the Barents Euro-Arctic Council.

The Division for Chemicals works on issues relating to environment and health, and to products and their lifecycles. This includes among other responsibilities nuclear safety, radiation protection and management of radioactive waste. The Division works on action at national level but also participates in negotiations in the EU and internationally.

The Division for Environmental Analysis coordinates and governs the Ministry's work on the environmental objectives system. The Division's responsibilities include environmental research, environmental monitoring, environmental policy instruments, environmental impact assessments, wind power and regional and local strategic climate and energy initiatives.

It is also responsible for environmental aspects of transport infrastructure issues and processes administrative matters under the Swedish Environmental Code.

Government authorities:

- Statens Energimyndighet (STEM), Swedish Energy Agency

The Swedish Energy Agency is the central Government body responsible for the main authority functions within the energy area. It is a separate Government agency supervised by the Ministry of Enterprise, Energy and Communications. The Swedish Energy Agency works towards transforming the Swedish energy system into an ecological and economically sustainable system through guiding state capital towards the area of energy. This is done in collaboration with trade and industry, energy companies, municipalities and the research community.

Specific responsibilities include:

  - Planning and running energy and environment computer modelling projections to develop forecasts;
  - Delivering official energy statistics and policy analysis
  - Implementing and overseeing the long-term energy policy programme for RD&D,

- Supporting innovation, business development and commercialization for market introduction of new energy technologies (clean tech)
- Promoting Swedish clean tech on international markets
- Acting as designated Focal Point for JI and Designated National Authority for CDM and official Swedish point of contact for JI and CDM with regards to the Climate Convention.
- Administering the electricity certificate trading programme for support of renewable energy,
- Implementing Sweden's energy efficiency measures, including implementation of programmes for: Industry, Transport, Housing, support to Local and regional levels, Market development of energy services
- Testing of energy related products; carrying out market surveillance of labelling and eco-design of energy use in energy related products and other consumer goods.
- Promoting the development of wind power, taking a holistic approach to encourage its rapid expansion.
- Securing of supply and Emergency preparedness.
- Taking part in international collaboration and bilateral agreements

- Energimarknadsinspektionen (EI), Energy Markets Inspectorate

The Energy Markets Inspectorate is the Swedish regulator of the markets for electricity, natural gas and district heating. The Inspectorate works for an improvement of the functioning and efficiency of these markets. Operations are regulated by the Government through the inspectorate's instructions. The guidelines for current operations are set out in our annual appropriation directions.

The aim of the Government's energy market policy is to promote efficient markets with well-functioning competition that ensure a reliable supply of energy at internationally competitive prices. This means that efforts have to be made to establish markets where the utilization of resources and price formation are efficient.

- VINNOVA, Swedish Governmental Agency for Innovation Systems

VINNOVA integrates research and development in technology, transport and working life. Its mission is to promote sustainable growth and competitiveness by financing RTD and developing effective innovation systems.

- Konkurrensverket, Swedish Competition Authority.

The Swedish Competition Authority works to safeguard and increase competition in Sweden. In addition to applying the Competition Act, the Authority provides proposals for changes to rules and other measures to eliminate obstacles to effective competition, as well as builds up and disseminates knowledge on competition issues.

- Elsäkerhetsverket, Swedish National Electrical Safety Board

The Swedish National Electrical Safety Board aims to prevent injury to persons and damage to property caused by electricity. It also has the task of creating a satisfactory electromagnetic environment in which different pieces of apparatus can operate without disturbing each other.

- Boverket, National Board of Housing, Building and Planning

The National Board of Housing, Building and Planning is the national agency for planning, management of land and water resources, urban development, building and housing. It is responsible for promoting the efficient use of energy in buildings, notably the reduction of use of electricity for residential heating and implementation of the building regulations.

- Strålsäkerhetsmyndigheten (SSM), Swedish Radiation Safety Authority

The Swedish Radiation Safety Authority works proactively and preventively with nuclear safety, radiation protection and nuclear non-proliferation in order to protect people and the environment from the harmful effects of radiation, now and in the future.

- Naturvårdsverket (NV), Swedish Environmental Protection Agency

The Swedish Environmental Protection Agency has a key role in environmental work, as a proactive and cohesive force in implementing environmental policy.

- Konsumentverket, The Swedish Consumer Agency

The Swedish Consumer Agency has the task to safeguard consumer interests.

- Forskningsrådet (Formas), Swedish Research Council

Formas promotes and supports basic research and need-driven research in the areas of Environment, Agricultural Sciences and Spatial Planning. Formas is committed to excellence in research for sustainable development.

- Transportstyrelsen, Swedish Transport Agency

The Swedish Transport Agency is working to achieve good accessibility, high quality, secure and environmentally aware rail, air, sea and road transport. They have overall responsibility for drawing up regulations and ensuring that authorities, companies, organisations and citizens abide by them.

- Trafikverket, Swedish Transport Administration

The Swedish Transport Administration is responsible for overall intermodal long-term infrastructure planning for road, rail, sea and air travel, as well as for the planning, building, operations and maintenance of the state roads and railways. The task of the Swedish Transport Administration is to apply an urban management perspective to create the conditions for an economically efficient, internationally competitive and long-term sustainable transport system.

- Trafikanalys, Transport Analysis

Transport Analysis is the Government s evaluation and analysis body for issues concerning the whole area of transport. This agency is responsible for evaluating measures and reporting the effects of various measures in the area of transport. Transport Analysis is also responsible for studies into travel habits and transport, as well as official statistics in the area of transport and communications.

- Väg- och transportforskningsinstitutet (VTI) Swedish National Road and Transport Research Institute

The Swedish National Road and Transport Research Institute perform research and development concerning infrastructure, traffic and transport. The R&D shall also include general analyses of the impact of the transport sector on the environment and energy use.

- Myndigheten för samhällsskydd och beredskap (MSB) – Swedish Civil Contingencies Agency

The task of the MSB is to enhance and support societal capacities for preparedness for and prevention of emergencies and crises.

Public Enterprises

- Svenska Kraftnät (SvK), Swedish National Grid

The Swedish National Grid runs the national grid for electric power.Svenska Kraftnät’s mission is to:

- provide transmission of power on the national grid well in compliance with security, efficiency and environmental requirements
- perform the system operator function for electricity and natural gas cost-efficiently
- promote an open Swedish, Nordic and European market for electricity and natural gas
- ensure a robust nationwide supply of electricity.

It is a 100 % state-owned public utility.

- Sjöfartsverket, Swedish Maritime Administration

The Swedish Maritime Administration is responsible for shipping safety and accessibility. The Administrations component of the national objective for transport policy is to ensure that shipping can operate safely and efficiently throughout the year and to all Swedish harbours of importance. The Administration also has the task of working for high safety on board Swedish ships and for more environmentally sound shipping.

- Statens Järnvägar, Swedish State Railways

Swedish State Railways is a public enterprise that manages the property and is responsible for the operations that formed part of the operations of Swedish State Railways in 2000 and that were not transferred to limited companies at the end of 2000 or subsequently discontinued or transferred to government agencies or limited companies. The operations of Swedish State Railways have the following tasks:

- Management of leasing and leasehold commitments
- Vehicle management
- Administration and phasing out of various commitments such as staff, real property, archives, etc.

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1-E Taxation policy

Present energy taxation policy is aimed at reaching the climate and energy-related goals, while at the same time having a fiscal role. The energy tax was introduced

in the 1950s and the carbon dioxide tax was introduced at the time of a major tax reform in 1991.

It is difficult to separate the effects from the taxes, as both the energy tax and the carbon dioxide tax have fiscal functions as well as steering effects. In order to encourage greening, the environmental taxes have repeatedly been altered since 2000.

Tax levels for various purposes are calculated as percentages of the general level. The general carbon dioxide level has been increased from SEK 0, 37/kg CO2 in 2000 to SEK 1, 10/kg CO2 in 2011.

Participation in EU-ETS is a major reason for tax level differentiation; the carbon dioxide tax is zero for industries participating in the EU-ETS. Fuel used for electricity production is exempted from energy and carbon dioxide taxes (but not necessarily from sulphur and nitrogen taxes).

The tax on carbon in domestic refuse was abolished in 2010.

Various changes in the taxation system have been made in accordance with the Government Bill 2009/10:41 with the purpose of achieving more efficient energy use by reducing the number of exemptions through tax increases on both energy and carbon dioxide tax. On 1 January 2011, the energy tax for diesel was increased by an initial increment of SEK 0.2/litre. The second increase, also by SEK 0.2/litre, will take effect on 1 January 2013. This will be offset by a lower motor vehicle tax for diesel cars. Furthermore, the reduction of carbon dioxide tax on natural gas will brought down in 2013 to 20%. The tax reduction applies in the case of motor fuel consumption and will be discontinued completely in 2015. For industries outside the EU-ETS the carbon dioxide tax was increased in 2011 from 21 % to 30 % of the general level and an increase to 60 % in 2015 has been announced. For fuels used by industry for heating purposes (regardless of participation in the EU-ETS) an energy tax of 30 % of the general level was introduced in 2011. Heat production from CHPs in the EU-ETS is also subject to this tax rate together with an additional carbon dioxide tax of 7 % of the general level.The so called 0.8 %-rule will be abolished in 2015. According to this rule, a number of energy intensive companies whose costs for energy exceed 1.2 % of turnover, pay only 24 % of the carbon dioxide tax which would otherwise have been levied on them for energy exceeding the 1.2 % threshold.

The Swedish Tax Board is the responsible for the implementation of the taxes.

Table 1: Selected energy and carbon dioxide taxes as of 1 January 2012

Fuel	Energy tax	CO_2 tax
Fuel oil, diesel heating oil, SEK/m^3	819	3100
Coal, SEK/tonne	622	2697
Natural gas as vehicle fuel, SEK/1,000 m^3	0	1624

Natural gas for other purposes, SEK/1,000 m^3	904	2321
Petrol, environmental class 1, SEK/litre	3.14	2.51
Electricity, general level, SEK/kWh	0.290	0
Electricity, general level, Northern Sweden, SEK/kWh	0.192	0
Electricity, industrial processes, SEK/kWh	0.005	0

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1-F Fuel mix

Table 2: Energy balance, TWh

Energy demand (TWh)	**1990**	**2000**	**2005**	**2010**	**2020**	**2030**
Industry	140	153	154	147	161	166
Transportation	76	79	91	91	94	89
Residential and tertiary sector	150	148	149	156	149	148
Foreign aviation & maritime transport	14	25	31	32	35	37
Non energy purposes	23	21	25	32	31	33
Distribution and conversion losses	172	154	190	148	189	189
Total energy demand	587	581	639	604	659	662
Energy supply (TWh)	**1990**	**2000**	**2005**	**2010**	**2020**	**2030**
Oil products	190	197	204	190	189	184
Natural gas and gasworks gas	7	8	10	19	9	8
Coal and coke	31	26	28	23	26	27
Bio fuels, peat etc.	67	91	109	128	153	162
Waste heat, heat pumps	8	7	6	5	8	8
Hydro power, gross	73	79	73	68	70	70
Nuclear power, gross	202	168	215	166	216	216
Wind power gross	0	0	1	4	11	11
Import-export of electricity	-2	5	-7	2	-24	-23
Total energy supply	575	581	639	604	659	662

For targets on shares of renewable energy and increased electricity production from renewable sources, see indicators in section 1-C and chapter 4 on renewable energy.

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Reference: Energy in Sweden 2011 (STEM yearly key publication)
http://213.115.22.116/System/DownloadResource.ashx?p=Energimyndigheten&rl=default:/Resources/Permanent/Static/3928fa664fb74c2f9b6c2e214c274698/Energy_In_Sweden_2011_TA.pdf

2. Climate Change

2-A Policies and measures overview including major changes since previous IDR

Sweden uses a combination of general economic policy instrument s (taxes, electricity certificates for renewable energy, EU ETS) often in combination with the extensive provision of information. In addition to this research, innovation, demonstration and commercialisation are actively promoted. The budget for energy related research, which almost entirely has effects on climate change too, amounted to almost 1,4 biljon SEK in 2012. In total more than 2 billion SEK were assigned in 2010 by six governmental institutions.[1]

The following measures are out of use since the previous IDR: KLIMP Investment Programme, which was replaced by the initiative "the Delegation for Sustainable Cities".

Please note that some climate and energy related measures and initiatives are mentioned in other chapters, such as tax policies and the programme for energy efficiency in industry (PFE).

Swedish Roadmap towards 2050

Based on the 2009 Climate and Energy Bill the Government's vision for 2050 is that "by this time Sweden will have a sustainable and resource-efficient energy supply with no net emissions of greenhouse gases into the atmosphere". This vision should be achieved through cost effective policies and measures that include the whole economy

The Government has given the Swedish Environmental Protection Agency, in collaboration with the Swedish Energy Agency the task to develop a report that will provide and contain several scenarios achieving the goal and make the ground for a Swedish roadmap working to achieve the vision of Sweden without net emissions of greenhouse gases by 2050. The task should be completed by the end of 2012. The study will be performed recognizing international treaties and will take into account current climate change policies under the UN Climate Change Convention such as implication of Land use, land-use change and forestry (LULUCF) accounting rules and the use of market based mechanisms. The first interim report was recently published.

Reference: Underlag till en svensk färdplan för ett Sverige utan klimatutsläpp 2050, Delrapport http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6487-7.pdf

[1] Riksrevisionen, 2012; Svensk klimatforskning– vad kostar den och vad har den gett?

Energy indicators

In order to facilitate the follow up of the achievements of Swedish energy targets several energy indicators have been developed. The indicators are derived from official energy statistics. The indicators can be divided into basic indicators, which are updated annually and further developed and revised where necessary and thematic indicators. The thematic indicators aim to follow up the energy targets within a certain area that is chosen on an annual basis. In 2011 the theme was energy efficiency, which entailed indicators that illustrated changes in energy use in the transport sector, industry, power and district heating. In 2011 the Swedish Energy Agency also produced a report analysing a broad variety of energy efficiency indicators and proposing a setup of indicators for different aspects of energy efficiency.

Reference:
http://213.115.22.116/System/TemplateView.aspx?p=Energimyndigheten&view=default&cat=/Rapporter&id=a07ac6501d42472c9b04eb477851b071

The Delegation for Sustainable Cities.

This initiative replaces the former KLIMP (the local climate investment programme) initiative. The initiative is intended to stimulate the development of attractive urban environments in a way that contribute to reduced climate and environmental impacts, which can serve as models both nationally and internationally for sustainable urban development and applied environmental technology. The Delegation is to provide support to companies and municipalities for measures that contribute to the creation of attractive and sustainable urban environments with reduced climate impact. Support may relate to new construction or refurbishment and may contain measures in the fields of energy, water, waste and transport, but also in other sectors. There is special focus on city planning projects that substantially reduce greenhouse gas emissions. The delegation will continue its work until 2013.

Reference: http://www.hallbarastader.gov.se/bazment/hallbarastader/en/start.aspx

Super-green car rebate

As of 1 January 2012, the Government introduced a rebate for super-green cars (supermiljöbilspremie), it is SEK 40 000 (roughly 4500 Euro) for individuals and 35 per cent of the excess cost for the super-green car, or at most SEK 40 000 for legal entities. A super-green car is a passenger car that meets the latest EU exhaust requirements and emits a maximum of 50 grams of carbon dioxide per kilometer. The purpose of the rebate is to stimulate the market introduction of electric cars and plug-in hybrids and is one of several steps towards a fossil-free

vehicle fleet by 2030. The financial framework for the rebate is SEK 200 million for 2012-2014.

Reference: http://www.sweden.gov.se/sb/d/14350/a/174597

Public procurement of vehicles

The Government is since 2005 encouraging purchases of environmentally friendly cars through public procurement, in addition to preferential taxation. In 2007, 85% of all cars purchased by the public sector and at least 25% of emergency services vehicles should be environmentally friendly, increasing from 50 % in 2005 and 75 % in 2006. Since a new definition of an environmentally friendly car was adopted in 2006 to include gasoline and diesel driven cars with low fuel consumption, the procurement criteria has been extended.

Consideration of climate in the long-term infrastructure planning

The long-term planning for the development of new infrastructure has an impact on the prospects of society fulfilling its objectives for accessibility in an efficient and environmentally friendly way. Swedish infrastructure planning is based on all investments having to be economically viable and external factors being internalised in the cost estimate, including greenhouse gas emissions. Transport infrastructure planning is coordinated between the various transport agencies to utilise opportunities for intermodal measures and coordination gains. A transport mode-transcending approach is of key importance in the planning of measures to handle the combined environmental effects of the transport system. This approach is to be strengthened, and from 2009 infrastructure planning has been placed under the Swedish Transport Administration.

Reference: www.trafikverket.se also http://www.trafikverket.se/Foretag/Planera-och-utreda/Planer-och-beslutsunderlag/Nationell-planering/Nationell-plan-for-transportsystemet-2010-2021/Inriktningsunderlag-2010-20191/

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2-B Previous IDR recommendations

The government of Sweden should:

Climate change

- *Continue efforts to reduce energy-related GHG emissions and prepare for post-Kyoto by developing integrated and co-ordinated energy and GHG scenarios and policies.*

- *Increase the use of cost-effectiveness (SEK/t CO2 avoided) as a criterion for prioritising measures to lower GHG emissions.*

Action taken:

In 2009, the Government proposed a Climate and Energy Bill, which was then approved by the Parliament in 2009. The Bill includes a long term vision that Sweden will have a sustainable and resource-efficient energy supply system with no net emissions of greenhouse gases into the atmosphere by 2050.

The Bill includes national targets for the period up to and including 2020. The target stipulates that the emission in the non-trading sector, by 2020, should be 40% below the emissions in 1990. This target applies only to the sectors outside the EU Emissions Trading System, Two-thirds of this reduction should take place in Sweden and one-third in the form of investments in other EU countries or in flexible mechanisms such as the Clean Development Mechanism (CDM).Use of CDM and JI to reach the target in the non-trading sector by 2020 result in an increased cost-effectiveness (SEK/t CO2 avoided) to lower GHG emissions.

- *Consider more JI/CDM projects as a cost-effective way to meet GHG targets in the long term.*

Action taken:

The Government of Sweden has increased the budget for purchasing emission reductions from CDM- and JI-projects. Sweden's investment programme for JI and CDM contributes to cost effective emission reductions (more information about the programme see section 2F). The Swedish Government has so far granted a budget of more than 1 800 million SEK for the period up to and including 2014. The Government stated in the proposed Climate and Energy Bill that they plan to allocate further amounts to the CDM and JI purchase programme.

In the Climate and Energy Bill from 2009 the support for marked based mechanisms was highlighted, indicating their strong role as cost effective measures to curb GHG emissions. The emissions in the non-trading sector in Sweden shall be reduced by 40 %, compared to 1990 year levels, by 2020 according to the bill. One third of the emission reductions will come in the form of investments in other EU countries or in flexible mechanisms such as the Clean Development Mechanism (CDM).

The Bill further stipulates that for CDM-projects, there should be an increased focus on least developed countries (LDC) and small island states (SIDS). The Swedish CDM and JI purchase programme has proactively been engaged in development of CDM projects, both through bilateral projects and engagement in international carbon funds governed by the multilateral banks, such as the World Bank, the Asian Development Bank, and the Nordic Environment Finance Corporation. Sweden also actively participates in several forums on the developments of the existing market based mechanisms as well as developments of new market based mechanisms.

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2-C Greenhouse gas (GHG) and CO2 targets and progress

As described above the new joint climate and energy policy from 2008 includes that by 2020 Sweden should have:

- 40 per cent reduction in greenhouse gases compared to 1990

Long-term priorities and vision beyond 2020:

- By 2030, Sweden should have a vehicle stock that is independent of fossil fuels.
- A vision that, by 2050, Sweden will have a sustainable and resource-efficient energy supply and no net emissions of greenhouse gases in the atmosphere

http://www.sweden.gov.se/content/1/c6/12/00/88/d353dca5.pdf

http://www.regeringen.se/content/1/c6/12/27/78/4ce86514.pdf

http://www.regeringen.se/sb/d/15365

In parallel to the vision that Sweden should have a sustainable and resource-efficient energy supply system with no net emissions of greenhouse gases into the atmosphere by 2050, Sweden has, along with the EU, declared its commitment to enter into a second commitment period of the Kyoto Protocol. Targets, rules and length of the commitment period are however still to be negotiated.

Progress towards targets

During the first commitment period of the Kyoto Protocol Sweden has a commitment under the Kyoto Protocol and the EU burden sharing agreement of + 4 % compared to 1990. Projections indicate that Sweden is going to reach its

commitment by a considerable margin[2]. The emissions in Sweden have gradually and steadily decreased for more than two decades, despite a steadily increased economic growth. Sweden has thereby shown that it is possible to reduce greenhouse gases and have an economic growth, so called decoupling.

The emissions have decreased from approximately 72 million ton CO_2 in 1990 to just above 66 million tons in 2010. This can be explained by a mix of policies and measures, for instance replacement of oil based heating with heat pumps, district heating or pellets. Emissions per capita have decreased from 8, 4 ton CO_2e (6, 6 ton CO_2) 1990 to approximately 7 ton CO_2e (approximately 5, 5 CO2) during the period from 2005–2010.

Reference: Swedish Environmental Protection Agency 2011

According to the Environmental Protection Agency, the prognosis is that emissions will continue to slowly decrease, and in 2020 the total emissions of greenhouse gases are expected to be about 17 % below the 1990 level and in 2030 around 19 % below the 1990 level. Below is a table on projected emissions up to 2020. The projection is derived from the Report for Sweden on assessment of projected progress in accordance with article 3.2 under Council Decision No 280/2004/EC on a Mechanism for Monitoring Community Greenhouse Gas Emissions and for Implementing the Kyoto Protocol, which was submitted in spring 2011. The table has then ben updated with regard to actual emissions in 2010.

For more information on prognosis and emission statistics reference is made to the Swedish Environmental Protection Agency www.naturvardsverket.se , http://www.swedishepa.se/In-English/Start/Climate-change/Greenhouse-gas-emissions/Tables-on-greenhouse-gas-emissions/

Table 3: Historical emissions 1990-2010 and projected emissions of greenhouse gases 2011-2020 for different scenarios in the sensitive analysis excl. LULUCF (Mt CO2-equivalents)

	1990	2007	2009	2010	2015	2020	1990-2010	1990-2020
Projection	72.5	65.8	60.0	66.2	60.8	59.9	-16%	-17%
Scenario "lower emissions" (with higher fossil fuel prices in the energy and transport sector and lower emissions from fluorinated greenhouse gases)	72.5	65.8	60.0	66.2	59.4	58.0	-16%	-20%

[2] Note that these figures still are uncertain and only preliminary since the final calculation on target fulfilment will be made in 2014.

Scenario "higher emissions" (with higher economic development in the energy and transport sectors, higher production in agriculture and higher emissions from fluorinated greenhouse gases)	72.5	65.8	60.0	66.2	62.0	62.1	-15%	-14%

2-D Division of responsibilities

Since 2006, the responsibility for climate change policy rests with the Ministry of the Environment. Efforts to limit impact on the climate, is integrated into all sectors of society and covered by all actors, a strategy that for a long time has been central to Swedish environmental policy. Government authorities also have sector responsibility for the implementation of climate policy in their areas, which is also the case for municipalities and county administrative boards, for example in work on physical planning, infrastructure development, municipal action etc.

Swedish efforts in relation to climate change and the national objectives are continuously monitored and evaluated. There was a checkpoint in 2008; the next one will take place in 2015. The aim of the check points is to analyse the developments in relation to the national objectives. The Swedish Environmental Protection Agency and the Swedish Energy Agency were commissioned by the government to prepare data ahead of the checkpoint in 2008. The output from the checkpoint in 2008 provided input to Sweden's Climate and Energy Bill. The next checkpoint in 2015 will analyse the development in the area of energy, the balance between different sources of energy and associated costs as well as climate impacts in relation to the targets. The next coming checkpoint will also analyse the state of knowledge of climate change.

2-E Emissions trading and national allocation plans (if applicable)

The existing EU ETS installations in Sweden have been allocated 19.8 million emission allowances in average per year between 2008 and 2012. In addition to that there is a reserve for new entrants that amount to 13.1 million tonnes of carbon dioxide for the entire period. The existing installations in the sector of electricity and district heating have no free allocation of emission allowances, while the industry received free allocation to fixed criteria.

The preliminary free allocation in EU ETS phase 3 was notified to the European Commission on 27th of January 2012 by the Swedish Environmental Protection Agency. The final decision will be made in the spring 2012 by the Swedish Environmental Protection Agency, after review by the European Commission.

The free allocation for phase three of the EU ETS has followed the Commission decision 2011/278/EU. No free allocation has been given for electricity production. 636 installations in Sweden will receive free allocation of emission allowances for phase three of the EU ETS, of which 22 are new installation after 2012. The preliminary free allocation for 2013 is 30.2 million EUAs and for 2020 24, 0 million EU emissions allowances (EUAs).[3] The preliminary figures are before the application of the linear reduction factor that will be decided by the Commission.

Table 4: Preliminary free allocation to Swedish installations in EU ETS 2013-2020. The figures are before the application of the linear reduction factor.

2013	2014	2015	2016	2017	2018	2019	2020
30243577	29344058	28444772	27552387	26660961	25769587	24877055	23985792

As from 1 January 2012 airline operators are included in the EU ETS. 17 airline operators who applied for allowances in Sweden in accordance with EU regulations have been allocated allowances. In 2012 the aviation sector was allocated equal to 97 per cent of the sectors average emissions per year from 2004 to 2006. For the period of 2012-2020 the number of emission allowances will be reduced with 97-95 per cent of the average emissions in 2004-2006.

The historical and projected emissions of greenhouse gases (Mt CO2 – equivalents) for sectors covered in the EU ETS excluding aviation is shown in table 5.

Table 5: Report for Sweden on assessment of projected progress, March 2011, Swedish Environmental Protection Agency.

	2005	2008	2009	2020
EU ETS (SWE)	23,7	22,6	19,8	22,8

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2-F International flexibility mechanisms

The Swedish Government has made all necessary preparations to be able to use the Kyoto Protocol's flexible mechanisms. The EU ETS directive and the linking directive are implemented; hence the EU ETS is one of the instruments used by Sweden to reach the target set under the burden sharing agreement. This

[3] http://www.naturvardsverket.se/Start/Lagar-och-styrning/Ekonomiska-styrmedel/Handel-med-utslappsratter/Handelsperioden-20132020/Tilldelning-till-stationara-anlaggningar/

implementation also encompasses a governmental purchase programme for emission reductions from CDM and JI project activities.

The Swedish Energy Agency currently administrates a programme for Joint Implementation and the Clean Development Mechanism, the Swedish CDM and JI programme. As previously mentioned the accumulated budget up to and including 2014 is approximately 1 800 million SEK. The Government stated in the Bill from 2009 that they plan to allocate further amounts to the CDM and JI purchase programme.

The purpose of the Swedish CDM and JI programme is to contribute to the development of flexible mechanisms as credible and efficient tools in the international climate change co-operation. The programme will result in cost efficient emission reductions, and there should be a balance between bilateral projects and participation in funds. A regionally balanced portfolio is desirable. The programme has over the last few years had an increasing focus on projects in least developed countries (LDCs) and small island developing states (SIDS). Sweden is one of the EU countries that have an extra percentage from this category. The credits can be used to comply with commitments for the period after 2012 or to achieve national goals.

At the end of 2011 the Swedish CDM and JI programme had a portfolio consisting of 47 bilateral projects (45 CDM projects and 2 JI projects) and were participating in 7 carbon funds. For more information on the Swedish Purchase Programme for CDM and JI please visit http://www.energimyndigheten.se/en/International/For-a-better-climate/Flexible-mechanisms-for-monitoring-green-house-gas-emissions/Swedish-CDM-and-JI-climate-programmes-/

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3. Energy Efficiency

3 -A Policies and measures overview including major changes since previous IDR

Reference: Energy Efficiency Action Plan as reported to the EU-commission
http://ec.europa.eu/energy/efficiency/doc/end_use/neeap_article_10_j_s.zip

The new climate and energy policy adopted by Parliament in the beginning of 2009 (prop. 2008/09:1 63) covers a wide range of climate and energy-related topics, some of which directly address energy efficiency and thus form the legislative backbone of ensuing measures. Price signals through energy taxes, CO2-taxes and the EU ETS are crucial for influencing demand, while market failures, such as information failures, are addressed by specific information and counselling measures.

The legislative proposal sets the goal of a decrease in the energy intensity in Sweden of 20 % between 2008 and 2020. The action programme for energy efficiency included in the proposal sets up a five-year energy efficiency programme for 2010 – 2014, which is granted an annual SEK 300 million in addition to existing funding. This programme focuses on strengthening local and regional actions, information, counselling, support for technology procurement and market introduction, networking activities, and the introduction of support schemes with energy audit vouchers for SMEs. The public sector is to be a role model in energy efficiency. Energy efficiency will also be carried out in the building sector, industry and transport.

The environmental quality objectives call for a 20 % reduction of energy use in the building sector by 2020 and 50 % by 2050.

The Energy Efficiency Council (Energieffektiviseringsrådet) has been set up under the auspices of the Swedish Energy Agency in order to coordinate actions following from the Energy Service Directive.

To realise the profitable energy efficiency potential Sweden invests in a wide range of measures. Below is described what kind of activities the three main programmes may be used for. In 2012 the total public funds amounted to around 529 MSEK (59 million Euro).

Table 6: Funds for Energy Efficiency

	Funds 2012
Energy- and Climate Advisors and regional energy agencies	140 MSEK

Measures for sustainable energy use	119 MSEK
Action programme for energy efficiency	270 MSEK

Energy- and Climate Advisors and Regional Energy Agencies includes:

1. Energy- and Climate Advisors (reference: Förordning (1997:1322) om bidrag till kommunal energi- och klimatrådgivning)
2. Coordination, organisation and training of the Municipal Energy and Climate Advisors, evaluation and monitoring
3. Measures for information dissemination, as well as development and dissemination of tools, systems, methods and education in the area of energy efficiency and energy efficient technology targeted at local, regional or national actors
4. Financing projects of Regional energy agencies
5. Financing the implementation of EU-directives and EU-projects

Measures for Sustainable Energy Use includes:

1. Generation of methods for market introduction of existing or new energy efficient technology, energy efficient products, technology procurement and planning, development of systems, evaluation and monitoring of the activity, (Förordning (2003:564) om bidrag till åtgärder för en effektiv och miljöanpassad energiförsörjning)
2. Information- and training efforts, networking activities, development of methods, tools and systems
3. Testing of electrical or other energy related appliances
4. Financing the implementation of EU-directives and EU-projects
5. Financing of international collaboration within the area of energy efficiency
6. The programme “Sustainable Municipalities”

Action Programme for Energy Efficiency includes:

1. Public support for municipalities and county councils that are working strategically with energy efficiency (Förordning (2009:1533) om statligt stöd till energieffektivisering i kommuner och landsting).
2. Regional collaborative projects
3. Regional energy- and climate strategies
4. Energy audit vouchers (Förordning (2009:1577) om statligt stöd till energikartläggning)
5. Energy efficient technology procurement of products and systems plus methods for marked introduction of energy efficient vehicles and techniques (Förordning (2003:564) om bidrag till åtgärder för en effektiv och miljöanpassad energiförsörjning and Förordning (2008:761) om statligt stöd till forskning och utveckling samt innovation inom energiområdet),
6. Information and training, networking, studies, development and methods focusing on energy efficient public procurement, small and medium sized enterprises, children and youth
7. Information and methods for energy services, energy performance contracting
8. Information measures to promote energy declarations of buildings
9. Development and maintenance of a list over energy efficient goods as a tool for purchasers.

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(1) Building Sector

To realise the profitable energy efficiency potential in the Swedish building and service sector a wide range of measures, including information, demonstration and dissemination takes place. The cross sectorial measures often deals with the potential in the building and service sector. The Swedish Energy Agency's work with energy efficiency in the building sector as described below is mostly financed by funds under the programme "Measures for sustainable energy use".

Major changes since last IDR

The **building code** was revised in 2012[4]. The present criterion is 90 kWh/m^2 in the southern climate zone and 130 kWh/m^2 in the northern climate zone (new residential buildings and buildings going through major renovation). For buildings equipped with direct electrical heating the criterion is 55 kWh/m^2 in the southern climate zone and 95 kWh/m^2 in the northern climate zone.

Reference: www.boverket.se

The demand for low energy buildings is increasing, there is however a lack of highly-qualified on-site 'blue collar' workers for the needed construction of nearly zero energy building. Therefore Sweden takes part in the **EU project Build Up Skills (Intelligent Energy for Europe2)** where the objectives are to develop a roadmap in order to describe how to increase the number of highly-qualified on-site 'blue collar' workers through further education/training and to increase their skills in building nearly zero energy buildings using renewable energy, energy efficiency and in low energy renovations of buildings. During the first phase of the project the national status quo is being analysed, the necessary skills determined and associated barriers are identified. A platform to endorse the activities is also developed during the project. The total budget for Build Up Skills Sweden is 408 114 EUR, EU funding is 90% of the budget, 367 302 EUR.

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Financial support for **demonstration of energy efficient buildings** is given to project development, monitoring, evaluation and information dissemination. The approach has been around for several years but is now scaled up to contribute to the conversion of buildings to nearly zero energy buildings.

It is considered that there is a particular need to address information failures in respect of such knowledge on modelling, methodology and analysis, procurement, implementation and evaluation of energy efficiency solutions for existing apartment buildings and premises of a global perspective. It is envisaged that a platform for broad demonstration support will be created focusing efforts and measures for dissemination and awareness-raising. Currently most of the marketing efforts are supported by the Swedish Energy Agency's partnerships with various networks e.g. BELOK (ordering group for premises[5]), BeBo[6]

[4] National Board of Housings Building Code http://www.boverket.se/Bygga--forvalta/Bygg--och-konstruktionsregler-ESK/Boverkets-byggregler-BBR-19/

[5] www.belok.se

(ordering group for apartment buildings) and by the programme for low energy buildings, LÅGAN[7].

LÅGAN (the name is derived from the Swedish word for buildings with a very low energy use) is one of the national initiatives that support improvements to increase the rate of construction of low-energy buildings. The programme started in 2010 and is planned to run for five years. It provides financial support for demonstration projects and local/regional collaboration initiatives. It also encourages new thinking by evaluating and disseminating information from demonstration projects, and by supporting development projects. LÅGAN is a collaborative effort between the Swedish Energy Agency; the Swedish Construction Federation; the Region of Västra Götaland; Formas; the National Board of Housing, Building and Planning; clients; contractors and consultants.

The current total budget for LÅGAN is approximately 6.9 million Euros. The Swedish Energy agency finances 2.4 million Euro and Formas, the Region of Västra Götaland and all participating organisations cover the remaining balance. The programme is intended to encourage new construction of and conversion to energy-efficient buildings, foster a national market for buildings with low energy use, and assist in the establishment of an extensive national body of suppliers of products and services and create confidence in them.

A market analyses performed by LÅGAN shows that the market share of new low energy buildings in 2010 was about 8 % for residential buildings (12% for apartment blocks) and about 8% for offices and other types of buildings. In 2010 over 5% of new apartment blocks were very low energy buildings like passive houses. These analyses will be performed again in the end of the programme and the expectations/hopes are that the market share of low energy buildings will be doubled within the period of the programme, until 2015. However, in order to reach that goal more resources will probably have to be allocated.

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The Energy Performance of Buildings directive (2010/31/EU) requires mandatory **energy certificates for buildings**. Following the revised directive Sweden has adjusted the system for certification of buildings inter alia by adopting the label of the energy labelling systems for appliances when labelling buildings.

Reference: www.boverket.se

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[6] www.bebostad.se
[7] http://www.laganbygg.se/in-english__14

In order to support the implementation of energy efficiency measures emanating from the energy declarations a web site, www.energiaktiv.se, has been set up. It was launched on 31 March 2011 and is aimed at encouraging a systematic and structured approach to energy efficiency work. Its primary focus is buildings, and energy declarations, but the focus will be expanded to cover agriculture, industry and transport during 2012. The setup costs for the website amounted to 1.5 million SEK and according to the impact assessment made it will contribute to energy savings of around 8 GWh annually.

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EU-directives 2006/32/EC on energy end-use efficiency and energy services and 2010/31/EU on the energy performance of buildings require the **public sector to lead by example**. National transposition of the EU-directives requires governmental agencies to monitor their energy use and carry out energy-efficiency measures.

Following the Energy Services Directive the Parliament adopted a **law on energy efficiency measures in government agencies**[8]. In Sweden about 180 agencies are affected by the Act. The agencies shall report annually on measures selected to implement the legislation and on their energy use to the Swedish Energy Agency. At least two measures from the Energy Services Directive Annex 6 have to be chosen. The work is often integrated in the environmental management of the agencies. Support through information and education for the agencies implementation is given by the Swedish Energy Agency. The funding of maintaining the support at is approximately 2.7 million SEK and the annual energy savings is, according to the authorities own reporting, around 230 GWh yearly. All figures are tentative.

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Approximately half of the non-residential building stock in Sweden is owned by the public sector. The public sector is also an important office-tenant. Roughly half of a building's energy end use is related to tenant energy use, mainly electricity. Thus the public sector is a large stakeholder in reaching compliance with the directives and goals of reduced energy end use and increased use of renewable energy sources. The Swedish Energy Agency finances a **liaison group**

[8] Förordning (2009:893) om energieffektiva åtgärder för myndigheter http://www.riksdagen.se/sv/Dokument-Lagar/Lagar/Svenskforfattningssamling/Forordning-2009893-om-energ_sfs-2009-893/

named HyLok, consisting of representatives from 10 governmental agencies. The aim of the group is to increase the focus on reduced tenant energy end use and to enhance cooperation between property owners and tenants in their joint efforts to increase energy efficiency in buildings while achieving long-term economic benefits. The HyLok group is a platform for exchange of ideas and experiences as well as a group driver for energy-efficiency projects.

Sustainable and energy efficient IT is another area of special focus for governmental agencies and HyLok has one sub-network working only with IT.

Reference: www.hylok.se

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(2) Appliances, Equipment, Lighting

Mandatory requirements on minimum **energy performance and energy labelling** of appliances is based on EU directives. Requirements today covers 13 product groups e.g. lamps, electric motors, refrigerators, pumps and washing machines. The adopted regulations and delegated acts have the potential to give an increased energy efficiency of about 385 TWh in the EU by 2020. Sweden focuses on supportive measures to realise the full potential of the eco-design and energy labelling directive through information, consumer advice and intensive market surveillance. The Swedish Energy Agency also performs testing of products that are not yet regulated to study their energy performance and other consumer aspects. The produced data is used as input to studies of coming regulatory measures, public procurement and consumer advice.

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The Swedish Energy Agency has been appointed as the national market surveillance authority for the EU Eco-design and Energy Labeling directives. During 2012-2014, the Swedish Energy Agency will participate in **Ecopliant**, an EU project (IEE2), which focuses on improved market surveillance (enforcement) of the Eco-design Directive and its regulations. Ecopliant aims to improve both market surveillance itself, and above all cooperation on market surveillance between the national market surveillance authorities in the EU. Throughout the project best practice will be developed, coordinated document inspection and testing will be conducted and results will be shared. In addition, training for all EU Eco-design market surveillance authorities will be organized. 10 countries participate in the project. Sweden plays a substantial role as leader of one of the "work packages" in the project.

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Another EU-project (IEE2) for improved control of Eco-design and Energy Labelling requirements on products is the **Atlete 2**. Atlete 2 will run from 2012-2014. The Swedish Energy Agency's market surveillance function will take part also in this project. The project builds on Atlete 1, which was initiated by the European trade association for major appliances (CECED), which aims to demonstrate compliance or particular discrepancy between eco-design/energy labelling requirements and the products on the market. In Atlete 2 focus will be on a major testing of washing machines. The Swedish Energy Agency participates in Atlete 2 as a formal market surveillance authority, which means that the Agency should act according to regulations if the tests show that the products do not meet current requirements.

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Lighting is one of the focus areas of the Swedish Energy Agency during 2011-2012. Lighting is currently going through major changes, however, some of the new solutions contain heavy metals e.g. mercury, which are hazardous to the environment and health.

The Swedish Energy Agency has allocated approximately 20 million SEK to the area of lighting. The funding will be used for information dissemination and awareness raising for the public and to the creation of a testing and developmental arena at the Agency. During 2012 a lighting laboratory will be built, where development, testing and standardisation of new lighting products and solutions for illumination will take place. This will allow several parties both from public sector and private companies as well as universities to explore new lighting innovations, products and solutions. It will also allow information and testing in cooperation with several liaison groups e.g. HyLok.

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Following the EU Eco-design directive, several product groups have reduced their average energy consumption with a maintained or improved function. While starting at energy classes C or D with A as the most efficient class on the label, the energy labelling has for some products had a dramatic development and has reached A+++. Even products not yet included in the labelling scheme have through the **testing activities** of the Agency been developed further. One focus group for these tests have been heat pumps (air-air, air-water, as well as different kinds of geothermal heating), both used as production of heat and hot tap water. These tests have gained a huge interest from consumers as well as producers and

have been translated to other languages and the information has also been shared with and used by ministries within the EU. Tests results are shared and presented at the website www.energimyndigheten.se and can be read and down loaded by the public. Results are also frequently used by the energy- and climate advisors in their work, see Cross-sectorial for more information on their work.

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(3) Industry

In 2004, the tax increase on industrial process-related electricity from 0 to 0, 5 Euro per MWh, representing the adoption of the EU's Energy Tax Directive, came into force. Subject to the tax are energy-intensive companies in the manufacturing industry, which have the opportunity of being granted tax exemption on their electricity consumption if they take action to improve their energy efficiency. The **Programme for Energy Efficiency in Energy Intensive Industry (PFE)** is a five-year voluntary programme, which started in January 2005 and is supervised by the Swedish Energy Agency in cooperation with the Swedish Tax Agency and a programme council representing the industries. The programme has attracted a large number of applicant companies (100), mainly from the pulp and paper (47 companies), but also from the mineral industry, steel and other metals, food industry and wood products. These companies consume more than 70 % of the energy used in the industrial sector and 30 % of the participants are small and medium-sized enterprises. The first programme period was finalised during 2009 and resulted in electricity efficiency measures of 1, 45 TWh (5 %) in total. Some 1300 electricity efficiency measures were taken to a total investment of 708 million SEK. In addition about 350 other efficiency measures, conversions to renewables energy supply and increased production of electricity were carried out resulting in an increased production of electricity of about 1 TWh. Participating companies have implemented and are carrying out certified standardised Energy Management Systems. The tax relief is 145 million SEK annually. The programme is now in its second period.

Reference: http://www.energimyndigheten.se/en/Energy-efficiency/Companies-and-businesses/Programme-for-improving-energy-efficiency-in-energy-intensive-industries-PFE/

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Major changes since last IDR

Small and Medium sized Enterprises may apply for financial support through an **Energy audit voucher**. The support may cover half the cost for carrying out an energy audit, up to a maximum of 30 000 SEK. The basic data received from the audit, for energy use and proposed efficiency measures are reported directly to a database. The audit report is sent to the Swedish Energy Agency for approval. The target group are SME's within the manufacturing industry and agriculture, but all enterprises with an energy use over 500 MWh are eligible. So far approximately 450 enterprises have applied for the support and the projected total applicants until 2014 is 1000 enterprises. The cost for the programme will be approximately 37 million SEK, including information measures and evaluation. From the reported audits average savings are around 490 MWh which would mean an estimated yearly figure of 490 GWh for all 1000 companies. This is however based on the audit report; the final report that will be produced two years after the audit will give the actual figures.

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National, regional and local networks to improve energy efficiency of SMEs, develop methodology and energy efficient technology as well as dissemination of already known measures are areas of special focus. There are national networks mainly for energy intensive SMEs while regional and local networks are open to all enterprises. Nearly all networks involve the regional energy offices and the local energy advisors. The **network Energy Efficiency in the Sawmill Industry, EESI**, started in 2010 and is now in its second phase. The purpose is to demonstrate a possible reduction of energy use in the sawmill industry by at least 20 % per produced m3 until 2020. A 20 % decrease in energy use within the Swedish sawmill-industry would mean a 1200 GWh savings in heat-energy plus 300 GWh savings in electricity. For the sawmill industry this means a total financial savings potential of 390 million SEK.

Reference:http://www.sp.se/sv/index/research/effenergi/ongoing/eneff_eesi/Sidor/default.aspx

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Within the area of Energy Services, focus is on raising the awareness and knowledge of consumers. The Swedish Energy Agency has held a number of courses focused on **Energy Performance Contracting**. However the energy services is being analysed further. A very important part of the work with energy

services has been, and will be, to bring structure to the market(s) and a clarification on market conditions. This is a necessary pre-requisite in order to increase competition and develop new business models. The energy service area can include a number of different projects. The Swedish Energy Agency spends approximately 1 million SEK and uses 1-2 full time employees for the implementation of the Energy Services Directive. The results are not yet possible to provide in kWh since they are aimed at structure, definition and capacity building.

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(4) Transport

Major changes since last IDR

In 2010 the Swedish Energy Agency decided to allocate a total of 70 million SEK during 2010 - 2013 for projects aimed at **improving energy efficiency in the transport sector**. Energy efficiency is referred to as modification and improvement of existing solutions in the passenger and goods transports. Funding would for example be granted to projects that facilitate transfer to more energy efficient modes of transport, improved utilisation through increased fill factor and projects that contribute to more efficient travel patterns for example by using IT solutions. The initiative consists of two programmes of 35 million each. One of the programmes focuses on research and the other on demonstration projects, technology procurement and market introduction of methods, products or services for energy efficiency of the transport sector. The energy efficiency potential for the demonstration projects that have so far been granted is estimated to be at least 623 GWh per year. The energy efficiency potential for the research and development projects may first be estimated when the final reports are compiled and the programme has been evaluated.

CO2-based vehicle tax, the Motor vehicle tax was changed in October 2006. Then it came to be based on the vehicle's carbon dioxide emissions instead of, as was previously the case, on the vehicle's weight. The purpose of this change was to encourage the sales of more low-carbon vehicles. With effect from 2011, the carbon dioxide multiplier will be increased. Some alleviation will be provided for vehicles capable of running on bio-based motor fuels. Starting in 2011, the vehicle tax for newly registered light goods vehicles, buses and motor caravans will also be subject to the carbon dioxide tax charge. The vehicle tax for heavy goods vehicles does not include a carbon dioxide multiplier element, but depends on the vehicle's weight and exhaust levels.

Reference: Swedish Tax Agency website:
http://www.skatteverket.se/otherlanguages/inenglish/employersbusinessescorporations.4.70ac421612e2a997f85800095906.html#Tax

Toll charge for heavy vehicles. Heavy goods vehicles and trailers weighing more than 12 tonnes are subject to a toll charge. The charge is based on the vehicle's exhaust emissions category and the number of axles, and is payable for one year at a time. Some offset alleviation is provided by a reduction in the vehicle tax.

With effect from 1 July 2009, **clean vehicles are exempted from vehicle tax** for five years. Previously, clean cars had a reduced notional taxable value, but with effect from 1 January 2012 the reduced notional value is only applicable to cars driven by gas or electricity. Following the EU directive on Clean and Energy Efficient vehicles, public authorities are also required to procure passenger cars or lease cars that are clean vehicles (SFS 2009:1), and that light goods vehicles with emission levels less than 230 g CO2/km.

With effect from 1 January 2012, a rebate of up to 40 000 SEK (around 4 000 Euro) is granted to buyers of **super-green cars** (cars which emit 50 g CO2 /km or less). 200 million SEK has by the Government been reserved for this purpose which means that buyers of about 5000 cars will be given grants.

In order to improve **information given to car consumers** an EU-directive (1999/94/EC) regulates that information on fuel consumption and emissions of carbon dioxide have to be provided at the store and in advertisement. No energy labelling has yet been introduced.

Reference: www.konsumentverket.se , Swedish Consumer Agency

There are many **local and regional policy instruments**. A congestion charge was introduced in Stockholm in 2007 with the purpose of funding investments in infrastructure, public transport and improving traffic flow and the environment. Similarly one will be introduced in Göteborg on 1 January 2013. Other examples include subsidised public transport in order to facilitate inter-modality towards energy efficient transport modes, free parking for clean vehicles and higher parking charges for all vehicles. Cycling has become increasingly important in many cities and large investments are being made in maintenance of and creation of new bicycle infrastructure.

(5) Cross-sectorial

Introduced in 1977, the **law (1977:439) on municipal energy planning** constitutes that every municipality should have an actual energy plan for supply and use of energy within the territory. The law was reviewed by the Swedish Energy Agency in 2011. The report concluded that the law is obsolete, and suggested that the Government should perform a broad overview of the distribution of roles between national, regional and municipal institutions as well as certain other actors within the energy and climate sector. It should also investigate how a modern and efficient regulation should be designed.

To be able to increase the knowledge for questions regarding energy, climate and transport to citizens and companies, Sweden has a system with **energy- and climate advisors** in every municipality. They provide impartial advice that is free of charge through seminars, by phone and at exhibitions. The Swedish Energy Agency coordinates the advisors and supports the development of their competence through training and conferences and by providing them with information material, both printed and on the Swedish Energy Agency website.

Reference: http://www.energimyndigheten.se/en/Energy-efficiency/Household/

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At the regional level there are 13 **regional energy agencies** that work with the sustainable use of energy. They are an important actor on the regional level working together with the County Administrative Boards, the municipalities and companies in the region. They support the municipal advisors on a regional basis and arrange network meetings and seminars. On their own initiative they also initiate many projects within the area of energy efficiency and renewable energy.

Reference: www.fsek.se

Major changes since last IDR

Since 2010, the Swedish Government has reinforced its support to local and regional work on energy and climate matters via **public support for the municipalities and county councils working strategically with energy efficiency** within their own spheres of influence. The aim is to encourage and support municipalities and county councils to set good examples for an effective use of energy in accordance with the directive 2006/32/EC (the Energy Services Directive). All Swedish municipalities and county councils that actively undertake work with energy efficiency receive annual financial support. The municipalities

and county councils in return commit to reporting the effects of their energy efficiency work each year to the Swedish Energy Agency. The commitments made by municipalities and county councils consist of establishing a strategy for energy efficiency and then working actively to implement it. The strategy must encompass an analysis of the current situation, goals for the organisation's energy rationalisation and an action plan with measures intended to achieve the goals.

The strategies have been reviewed by the Swedish Energy Agency, and in 50% of the cases they were approved only after being modified. The remaining years, the annual reviews will focus upon follow-up of the implementation of the action plans. The goals for energy savings initially set by the municipalities and county councils average at 10% 2009-2014 and 20 % 2009-2020. In January 2012, a number of key figures from the baseline data were published. This is intended to introduce a certain element of competition amongst the participants.

A total of 99 million SEK (EUR 11 million) has been reserved per year. The investment is included in the action programme for energy efficiency 2010-2014. As of February 2012, the financial support to municipalities and county councils has been applied for by all 21 county councils and 279 out of the 290 municipalities.

Reference: http://www.energimyndigheten.se/sv/Offentlig-sektor/Statligt-stod-till-energieffektivisering-i-kommuner-och-landsting/

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The **Sustainable Municipality Programme** started in 2003, as a five-year feasibility study with five municipalities. After almost five years, the programme was evaluated and the results were positive. The programme is now in its third phase, 2011-2014, covering 38 ambitious municipalities. The municipalities participating in the third phase of the programme have, at the implementation of the programme, good basic energy and climate initiatives. Under the Sustainable Municipalities Programme, they will develop leading strategies in areas such as land use planning and economic policy. The participating municipalities do not receive any financial support for their participation. Instead, the Swedish Energy Agency furnishes them with knowledge, information and networks, all of which to facilitate the work for each municipality.

The Swedish Energy Agency and other authorities contribute to building their expertise and know-how to their efforts. Cooperation with universities and researchers contribute their knowledge to help develop methods and tools within the programme. An important aspect of the programme is that the municipalities learn from each other’s experiences, provide support and discuss both possibilities

and obstacles that may lie ahead. The results and methods are disseminated to the other municipalities in Sweden, for example, within the framework of the Support for Energy Efficiency Improvements. The Sustainable Municipality Programme is funded through "Measures for sustainable energy use".

Reference: http://www.energimyndigheten.se/en/Energy-efficiency/The-Sustainable-Municipality/

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The **County Administrative Board** is the regional government in each county, in total there are 21 of them. They have an important strategic role and responsibility for developing and implementing regional energy- and climate strategies. They are responsible for ensuring that regional environmental and energy targets and objectives are implemented and reached. The Swedish Energy Agency provides financial support and capacity building through arranging workshops and trainings.

In 2010, three county administrative boards (Dalarna, Skåne, and Norrbotten) were declared by the Government as "**pilot counties**" in order to drive the development together with business and municipalities. They shall promote green progress with new jobs, growth and increased competitiveness and guide those counties that haven't come so far in their work with energy and climate strategies. In addition to further strengthening cooperation for climate and energy policy strategies, these counties will also evaluate the impact of national measures on the regional level and identify obstacles.

Since 2011, the Swedish Energy Agency has been assigned the task to provide guidance to the **inspectors with responsibilities under the Environmental Code**. This Code makes up the framework for environmental legislation in Sweden, and states that all businesses or other operations must have a self-monitoring system in order to be informed about the environmental impact of their activities, including their use of energy. In turn, this self-monitoring system enables operators to comply with all the rules in the Environmental Code.

The inspection and enforcement responsibilities exist at three levels: local, regional and national. Inspectors at the regional and local levels carry out inspections for companies within their region. National agencies mainly support the responsible authorities at regional and local levels, i.e. the county administrative boards and municipalities.

The Swedish Energy Agency´s responsibility is to guide the inspectors regarding operations that apply self-monitoring of their energy use. This includes

supporting, advising and evaluating inspection and enforcement work carried out at regional and local levels. By assisting the county administrative boards and municipalities to carry out better inspections, the aim is that operators and businesses are prompted to minimise their energy consumption and to improve their energy efficiency.

Reference: http://www.energimyndigheten.se/sv/Offentlig-sektor/Tillsynsvagledning/

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To be able **to increase children's and young people's awareness and knowledge of energy efficiency and climate**, the Swedish Energy Agency provides support to teachers and schools through extensive project funding, methods, materials, tools and networks. Energy is now also more explicitly a focus in several subjects of the new national curricula, that came into force as of August 2011.

Reference: www.energikunskap.se

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3 -B Previous IDR recommendations

The package of measures for improving energy efficiency described under 3-A, targets the previous recommendation to continue to engage with municipalities to further develop high-quality, individual and independent advisory services. Moreover, these measures also strengthen the capacity to identify and remove barriers to energy efficiency and allow for local approaches to develop means to enhance energy efficiency. Economic efficiency is a crucial for assessing the potential for energy efficiency, i.e. measures that are not cost efficient are, as a rule, avoided.

The government of Sweden should:

Energy efficiency

- *Review the economic potential for improving energy efficiency, identify the barriers, and develop measures to realise this potential.*

Action taken:

An official government inquiry reported in 2008 (Road to a more energy efficient Sweden (Vägen till ett energieffektivare Sverige SOU 2008:110), estimated

economic potentials for energy efficiency, though it is stressed that there are uncertainties in the estimates.

In the energy- and climate agreement of 2009, the Swedish government assessed that governmental measures to support energy efficiency should, in addition to energy- and climate taxes and regulation of the energy performance of various products and buildings, foremost be oriented towards removal of information and knowledge deficits. The ongoing energy efficiency programmes of the Energy Agency are reflecting this.

- *Continue to engage with the municipalities to further develop high-quality, individual and independent advisory services for energy saving.*

To realise the recommendations above Sweden engage with municipalities through:

- The Sustainable Municipality Programme
- Public financial support for the municipalities and county councils working strategically with energy efficiency
- A system with energy- and climate advisors in every municipality

For further information see 3-A

Buildings

The government of Sweden should:

- *Consider increasing support for renovation and refurbishment, for example by designing packages of measures for energy-related retrofitting and by considering strategies for their broad deployment.*

Action taken:

To realise the recommendation above Sweden works with:

- Providing financial support for demonstration of energy efficient buildings
- An ordering group for premises, BELOK, work with the model Totalconcept
- A programme for low energy buildings, LÅGAN

For further information see 3-A

- *Ensure sufficient funding for conversion grants to encourage more efficient space heating systems.*

Action taken:

In regard to this recommendation no action has been taken. All of the conversion grants that was available, mostly for private persons, are finished. So there is no funding for more efficient space heating systems in Sweden.

- *Monitor closely the compliance with the energy efficiency requirements in the building code.*

Action taken:

The building code was revised in 2012.

Industry

- *Maintain the voluntary Energy Efficiency in Energy-Intensive Industry scheme and consider ways to trigger greater energy efficiency investments in industry, including in SMEs.*

- The voluntary Energy Efficiency in Energy-intensive Industry scheme is in its second and last period. The work with finding an appropriate successor after 2014 when the current system is no longer allowed by the European Commission because of state aid rules has started.
- Small and Medium sized Enterprises can get financial support through an Energy audit voucher.

Transport

- *Encourage models for intermodal connections to and from metropolitan areas.*

Swedish Energy Agency allocates a total of 70 million SEK during 2010 - 2013 for projects aimed at improving energy efficiency in the transport sector.

The initiative involves two programmes open for project applications: one focusing on research projects and the other one on projects for demonstration, technology procurement, and market introduction of methods, products or services for energy efficiency in the transport sector. Examples may be projects facilitating the shift to more energy efficient modes of transport, improves the use by increased number of passengers or projects that contribute to more energy efficient travel patterns through reduced needs for transport, changed travel behaviour etc.

- *Monitor and, if needed, increase current efforts to reduce oil use in the transport sector by encouraging more efficient fuel use.*

The energy and climate advisors in every municipality work with energy efficiency in the transport sector and efficient fuel use.

In 2006, the Swedish motor vehicle tax was changed, to be based on the vehicle´s carbon dioxide emissions instead of, as was previously the case, on the vehicle's weight. The purpose was to encourage the sale of more low carbon vehicles. With effect from 2011, the carbon dioxide multiplier has been increased.

Bio based motor fuels pay no energy or carbon dioxide tax, which affects the profitability of using such fuels. The availability of bio based motor fuels has been affected by the requirement that filling stations selling more than a certain volume of fuel must also sell a renewable based alternative. As this requirement resulted mainly in an increase in the number of E85 pumps, a grant was also introduced for investment in other pumps. This grant is no longer available.

Cars provided as a benefit to employees are subject to tax. Biofuel driven cars have had reduced notional value for many years, which have had significant influence on the new cars' sales since around 50% of all new cars are purchased by corporate bodies (as company cars and benefit-in-kind cars). Earlier, ethanol cars had 80 % of the notional value compared to a similar gasoline driven car and biogas driven car had 60 % of the notional value. With effect from 1 January 2012, ethanol cars have the same notional value as a similar gasoline driven car. The reduced notional value is only applicable to cars driven by gas or electricity.

New cars sold in Sweden today are much more efficient compared to only a few years ago. In 2005, the average fuel consumption of new cars in Sweden was around 8 litres/100 km. In 2011 the corresponding consumption was 5,8 litres/100 km.

3 -C Energy efficiency, productivity, or intensity targets and progress

Energy efficiency in industry: The overall picture is ambiguous. On the one hand, significant improvement of energy efficiency (in terms of energy consumption in per unit of output) has been made in the paper and pulp industry and aluminium, while a reverse trend can be observed in steel and cement. (Energiindikatorer 2011).

Intensity targets and progress

The target is a 20 % reduction of energy intensity in GDP-terms by 2020 compared to 2008. Despite a downward trend, there are concerns that this target will not be reached (Långsiktsprognos 2011), with the reduction staying at 13 %. On the other hand, this target depends on the development of GDP and therefore the overall economic development will have a profound impact. Structural changes in industry and the economy as a whole are likely to have a significant impact on the progress towards reaching this target. If it is assumed that such processes will continue, the target can be reached with less effort. However, on the other hand, if the structural changes would take place at a slower pace, the target might not be reached. It should be added that if Sweden would impose a national target for reduction of primary energy as envisaged in the proposal for a new Energy efficiency directive in the EU, it would probably interfere with the intensity target.

3-D Division of responsibilities

The administration of energy efficiency programmes lies within the responsibility of the Swedish Energy Agency, while the actual measures are, as a rule, carried out at local and regional level; municipalities, county councils, county administrative boards or other private actors, e.g. companies. The National Board of Housing, Building and Planning is responsible for promoting the efficient use of energy in buildings, notably the reduction of use of electricity for residential heating and implementation of the building regulations. Taxes are the responsibility of the Swedish Tax Agency.

4. Renewables

4-A Policies and measures overview including major changes since previous IDR

The new climate and energy policy adopted by Parliament in the beginning of 2009 covers a wide range of climate and energy-related topics. By 2020, the share of renewable energy in the EU must correspond to 20% of its total energy use. On the basis of this, a national burden-sharing agreement has been decided for each member state, which for Sweden entails a renewable energy share of 49%. Sweden has further raised this goal so that its renewable energy share should be at least 50% of the total energy use.

The shares of renewable energy for land transport at EU level should by 2020, constitute at least 10%. Sweden's target for renewable energy in the transport sector is the same as that of the EU. In addition to this, the long-term aim is a vehicle fleet independent of fossil fuels in Sweden by 2030.

To achieve the goal of 50% renewable energy by 2020, Parliament adopted Bill 2009/10:133 to extend the electricity certificate system to the end of 2035.

In July 2011 the Government submitted to the Parliament Bill 2010/11:155 regarding a new Act for electricity certificates, opening the way for simpler rules and a common market for electricity certificates. The new Act contains:

- simplification of rules
- rules to facilitate a common market for electricity certificates with other countries
- more stringent requirements for electricity produced in hydro power stations
- exemptions from quota obligation requirements for smaller producers of renewable electricity who themselves use the electricity they have produced.

Sweden and Norway have come to a legally binding agreement on a common market for electricity certificates which commenced on 1 January 2012 and will last until the year 2036. The agreement was signed on 29 June 2011. The purpose of the common market is to improve market function, increase its cost effectiveness and give rise to a greater production of renewable electricity.

Table 7: Policies and measures for the promotion of renewable energy

Name and reference of the measure	*Expected result*	*Existing or planned*	*Start and end dates of the measure*	*Amount*
General				
Energy tax *Lag (1994:1 776) om skatt på energi, proposition 2009/10:41* (Act (1994:1776) on energy tax, bill 2009/10:41)	Fiscal and steering tax for more efficient energy consumption and increased share of renewable energy	Existing and planned adjustments of tax levels	Energy tax on petrol 1924, on the majority of other liquefied petroleum products and carbon fuels 1957, on LPG 1964 and on natural gas 1985-Changed 2011	
Carbon dioxide tax *Lag (1994:1776) om skatt på energi, proposition 2009/10:41* (Act (1994:1776) on energy tax, bill 2009/10:41)	Environmental tax to reduce emissions	Existing and planned adjustments of tax levels	1991 Changed 2010/2011	
Exemption from energy and carbon dioxide tax for CO2-neutral fuels and for vegetable and animal oils and fats and biogas as a heating fuel *Lag (1994:1776) om skatt på energi, proposition 2010/11:1* (Act (1994:1776) on energy tax, bill 2010/11:1)	Promotes the use of bioenergy.	Planned change in the tax exemption up to a certain level of mixture	1991- Changed 2011	
EU-ETS, Lag (2004:1199) *om handel med utsläppsrätter* (Act (2004:1199) on emissions trading)	EU-wide instrument →conversion to the use of renewable energy fuels	Existing. Planned adjustments	New period from 2013	
Electricity				
Marketing of wind power, *Förordning (2003:564) om bidrag till åtgärder för en effektiv och miljöanpassad energiförsörjning* (Regulation on grants for measures for efficient and environmentally friendly energy)	Development and demonstration support for wind pilot projects	Existing	2003-2007; 2008-2012	SEK 350 million 2008-2012. Total granted just over 400 million during 2003-2009, expected to generate 0.95 TWh (production is also eligible for electricity certificates)
Electricity certificate scheme, *Lag (2003:113) om elcertifikat* (Act (2003:113) concerning electricity certificates)	25 TWh new renewable electricity generation (previously 17 TWh) for 2020 (previously for 2016) compared with 2002	Existing and adjustment of quota levels (June 2009)	From 2003. The increase in ambition relates to the period 2013-2035	
Investment aid for photovoltaic	Target is that the number of operators	Existing. Additional funding from 2012	1 July 2009- (earlier 31 December 2011)	SEK 60 million during 2012. 2009-

cells connected to the grid, *Förordning (2009:689) om statligt stöd till solceller* (Regulation on government support for solar photovoltaic cells)	will increase in Sweden, that the system costs will be reduced and that electricity from solar photovoltaic cells will increase by 2.5 GWh during the period		extended (at least until 2012 according to the government's budget bill for 2012)	2011 a total of SEK 222 million was granted.
Investment support for biogas and other renewable gases, Förordning (2009:938) *om statligt stöd till åtgärder för produktion, distribution och användning av biogas och andra förnybara gaser* (Regulation concerning government support for measures for the production, distribution and use of biogas and other renewable gases)	Funding for projects that contribute to increased generation, distribution and use of renewable gases	Existing. Additional funds allocated for 2012 according to the government's budget proposition	1 November 2009-	SEK 60 Million per year during 2012 and 2013.
Support for climate and renewable energy projects, special funds allocated within Landsbygdsprogrammet (the Swedish Rural Development Programme), *Förordning (2007:481) om stöd för landsbygds-utvecklingsåtgärder* (Regulation concerning support for rural development measures)	Reducing climate impacts from rural companies and increased production and use of renewable energy in rural areas.	Existing	2010-2013	
Delegationen för Hållbara Städer (Delegation for Sustainable Cities), Förordningen (2008:1407*) om statligt stöd för hållbara städer* (Regulation concerning government support for sustainable cities)	Grants for sustainable urban development, in total SEK 320 million 2009-2010 to nine investment projects as well as 14 planning grants. In 2011and 2012 SEK 40 million will be granted mainly as planning grants.	Existing	2009-2010 and extended to December 2012.	
A new Act on guarantees of origin of electricity (2010:601), *Lag (2010:601) om ursprungsgarantier för el*	The purpose of the Act is to allow the end user to know the origin of electricity in a clear manner.	Existing	On 1 December 2010, a new Act on guarantees of origin of electricity entered into force	
Biofuels/Transport				
Obligation to supply renewable fuels (Pumplagen) (the Pump Act), *Lag (2005:1248) om skyldighet att tillhandahålla*	All retail outlets (above a certain volume) must supply renewable fuel	Existing	2006	

förnybara drivmedel (Act concerning the obligation to provide renewable fuels)				
Vehicle tax, *Vägtrafikskattelag* (2006:227) (the Road Traffic Act), and *Lag (2006:228) med särskilda bestämmelser om fordonsskatt* (Act with special provisions concerning vehicle tax)				
A new Act on environmental requirements in the procurement of vehicles and certain public transport services, *Lag (2011:846) om miljökrav vid upphandling av bilar och vissa kollektivtrafiktjänster* (Act (2011:846))	Promoting of clean and energy-efficient road transport	Existing	1 July 2011 -	
Exemption from vehicle tax for environmental cars, *Lag (2006:228) med särskilda bestämmelser om fordonsskatt* (Act with special provisions concerning vehicle tax)	Promoting environmentally friendly cars	Existing. Planned change.	2010, retroactive from 1 July 2009 - 2012	
Reduction in the amount of benefit for environmental cars, inkomstskattelagen (1999:1229) (the Income Tax Act) and Skatteverket's (the Swedish Tax Agency) regulations and general guidelines	Promoting environmentally friendly cars (compare the taxable benefit of environmentally friendly cars with equivalents alternatives, even though the environmentally friendly car is more expensive to purchase)	Existing. Planned change.	2009-2011 Alteration was introduced 1 January 2012-31 December 2013	
Implementing of the Renewable Energy Directive sustainability criteria. *Lag (2010:598) om hållbarhetskriterier för biodrivmedel och flytande biobränslen,* (Act (2010:598) concerning sustainability criteria for biofuels and bioliquids) Changes according to bill 2010/11:152, bill 2010/11:154 and Lag (1994:1776) om skatt på energi (Act (1994:1776) on energy tax)	Use of biofuels and bioliquids which leads to extensive reductions in carbon dioxide emissions and that has a low environmental impact.	Existing	On 1 August 2010, the Act concerning sustainability criteria for biofuels and bioliquids, came into force. To have tax exemption for certain biofuels it is necessary to receive a sustainability decision from 1 February 2012.	

A new Act on vehicle exhaust emissions control (2011:318) and a new Act on motor fuels (2011:319)	Reduced GHG emissions and promoting of renewable motor fuels	Existing	1 May 2011 –	
Super-green car rebate, *Supermiljöbilspremie*	Promoting environmentally friendly cars, renewable motor fuels and electricity for transport.	Existing	1 January 2012-31 December 2014	SEK 200 Million

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References:

National Renewable Energy Action Plan for Sweden (NREAPS) in accordance with the RES Directive
http://ec.europa.eu/energy/renewables/transparency_platform/action_plan_en.htm

First report on the development of renewable energy according to art 22 in the EU RES Directive.

http://ec.europa.eu/energy/renewables/transparency_platform/doc/article_22_progress_reports/article_22_progress_reports_english_language.zip

4-B Previous IDR recommendations

The government of Sweden should:

Bioenergy

- *Evaluate the optimum use of both indigenous and imported biomass supplies for heat, electricity, CHP, biofuels, biomaterials and bio chemicals in terms of economic, environmental and social benefits.*

Actions taken:

- The National Renewable Energy Action Plan for Sweden and itsupdate has been submitted (links above)
- An investigation of “Biobased society” has been launched. This is an assignment ordered by the Swedish government. Several authorities are involved: Swedish Energy Agency, The Swedish Research Council (Formas) and Vinnova (the Swedish Governmental Agency for Innovation Systems)
  http://www.formas.se/upload/EPiStorePDF/Bioekonomi/Bioekonomi.pdf

- Several investigations were carried out by the Swedish Energy Agency of the topic. These investigation are for the most governmental assignments a) included as assignment at the Swedish Energy Agency statute book or b) are special assignments commissioned e.g. by the Ministry of Enterprise, Energy and Communications. More detailed information is available on the Agency's website. http://www.energimyndigheten.se/Yttranden-och-avrapporterade-regeringsuppdrag/

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- *Increase international collaboration to assess the sustainable production of biomass.*

Actions taken:

Note that the following examples concern the Swedish Energy Agency involvement in international projects within the topic:

- BioGrace I, http://www.biograce.net/

  The project BioGrace aims to harmonise calculations of biofuel greenhouse gas (GHG) emissions and thus supports the implementation and transposition of the EU Renewable Energy Directive (2009/28/EC) and the EU Fuel Quality Directive (2009/30/EC) into national laws. The goal is to publish a uniform and transparent list of standard conversion values for GHG calculations, and Excel files will be elaborated as well as user-friendly GHG calculators for economic operators, auditors, and advisors to perform the GHG calculation step by step on their own. This will be done for the 22 most important biofuel production pathways cited in both directives. Project results shall be disseminated to European stakeholders through a website, meetings, and a series of workshops. National policy makers will be asked to make reference to the list of standard conversion values in their national legislation. The project has duration of 24 months and is now close to its final stage. The BioGrace II project is planned to start in a near future with focus on solid biomass fuels.

- Bioenergy Promotion I & II, http://www.bioenergypromotion.net/

  The Bioenergy Promotion project has promoted the development of a sustainable production of and commercialization of biomass in the Baltic Sea Region. The project started in January 2009 and is now in a stage of final reporting. The Swedish Energy Agency coordinated the project, which was a collaboration between 33 participating partners from ten countries around the

Baltic Sea: Belarus;, Denmark,; Estonia,; Finland,; Germany,; Latvia,; Lithuania,; Norway,; Poland and Sweden. The initiative for the Bioenergy Promotion Project initially came from the Baltic 21 secretariat. The project is has been part-financed from the EU Baltic Sea Region Programme, with a budget of about 5 million Euros. The follow up, Bioenergy Promotion II has started and will for two years work with implementation of project results from Bioenergy Promotion I.

- CA-RES, http://www.ca-res.eu/

The "Concerted Action supporting the transposition and implementation of Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (RES Directive) CA-RES" is a project supported by Intelligent Energy Europe (IEE). The CA-RES started in July 2010 and has duration of 3 years. The CA-RES is coordinated by the Austrian Energy Agency (AEA).

CA-RES is a structured and confidential dialogue supporting the effective implementation of the RES Directive 2009/28/EC. CA-RES will put emphasis on topics that require common approaches and that will benefit from coordination between the Member States as well as exchange of best-practice between Member States. It permits the Member States to discuss in confidence how best to implement the RES directive.

The main objectives of the Concerted Action on the RES Directive 2009/28/EC are as follows:

- Creation of a platform for structured dialogue and exchange of experience and best-practice between Member States regarding the implementation of the RES directive.
- Facilitate the process of cross learning at the EU level and provide support to an effective implementation of the RES Directive in the Member States.
- Encourage dialogue between the Member States on common approaches for the effective implementation of particular parts of the RES Directive.
- CA-RES aims to achieve these objectives by providing a series of 6 CA-RES Plenary Meetings for discussion of relevant topics. These plenary meetings provide a forum for structured discussions and cross learning between Member States. This exchange of approaches, experiences and best practices concentrates on key requirements of the Directive 2009/28/EC according to the needs of Member States and the European Commission.

The work of the CA-RES is structured in nine Working Groups covering the key requirements of the RES Directive:

1. Cooperation mechanisms and NREAPs
2. Calculation methodology
3. Authorisation of plants and infrastructure
4. RES and district heating planning, RES in buildings
5. Training and information + guarantees of origin
6. Electricity networks
7. Biogas networks
8. RES in transport and biofuels
9. Biomass mobilisation and sustainability
10. Guarantees of origin

- REFUREC, http://www.refurec.org/

The Renewable Fuels Regulators Club (REFUREC) is an informal club that offers a pan-European platform for discussion, information exchange and tackling cross-border issues relating to the biofuels market in the European Union and beyond.

REFUREC is open to institutions and organisations responsible for regulating biofuels within their respective countries and as such is primarily targeted to those who are or will be operators / administrators. Current REFUREC Members include about 20 organisations across Europe.

The club supports its members primarily through mutual knowledge exchange and advice on issues related to the operation and implementation of measures to support biofuels within the EU and beyond.

REFUREC facilitates discussion and sharing of knowledge and experiences in setting up national regulators (first years). Issues to be discussed will relate to relevant topics like the implementation of the Renewable Energy Directive and the Fuel Quality Directive.

- CEN TC 383

CEN TC 383, sustainably produced biomass for energy applications — Principles, criteria, indicators and verifiers for biofuels and bio liquids. The

standard is not mandated but focuses only on standardising the requirements in the Renewable Energy Directive (RES-D). Part 1 Terminology, contains definitions of terms. Part 2 Conformity assessment including chain of custody and mass balance, contains requirements for verification and auditing. Part 3 Biodiversity and environmental aspects, contains indicators for sustainability criteria required by (RES-D). Part 4 Calculation methods of the greenhouse gas emission balance using a life cycle analysis approach, contains calculation methodology in accordance with (RES-D). All standard parts are during 2012 out on formal voting by the member states. If voted through the standard will be finished during 2013.

- ISO PC 248

  ISO PC 248, Sustainability criteria for bioenergy, is a new standard being developed defining sustainability criteria for all types of bioenergy. The standard will focus on environmental, social and economic sustainability for processes throughout the chain of custody. Part 1, Cross cutting issues, including terminology and verification and audit, contains definitions of terms and requirements for conformity assessment and traceability. Part 2 Greenhouse gases, contains methodology for life cycle analysis of greenhouse gas emissions. Part 3 Environmental, economic and social aspects, contains principles, criteria and indicators for sustainability as well as direct effects. Part 4 Indirect effects, contains a report on indirect effects of producing sustainable bioenergy. The standard will be finished during 2014.

- CEN TC 411

  CEN TC 411, Bio based products is a mandated standard by the European Commission. The purpose of TC 411 is to develop standards concerning terminology, methods, criteria, guidance and tools applicable to bio-based products. The work concerns evelopment of standards for horizontal aspects, including sampling, bio-based content, application of LCA, sustainability criteria for biomass as well as developing certification scheme(s) for bio-based products, identifying which characteristics can/should be assessed and how they should be reported.

- Sweden is involved in several IEA tasks dealing with sustainable biomass production and use:
  - Task 32 Biomass Combustion and Co-firing
  - Task 36 Integrating Energy Recovery into Solid Waste Management
  - Task 37 Energy from Biogas and Landfill Gas
  - Task 38 Greenhouse Gas Balances of Biomass and Bioenergy Systems

- Task 39 Commercialising Liquid Biofuels from Biomass
- Task 40 Sustainable International Bioenergy Trade - Securing Supply and Demand
- Task 43 Biomass Feedstocks for Energy Markets

- The Ministry of Enterprise, Energy and Communcations is a partner under the Global Bioenergy Partnership (GBEP). Sweden has been active in the work of GBEP including its working group on criteria and indicators for sustainable biomass. This work is intended to provide relevant, practical, science-based, voluntary sustainability criteria and indicators to guide any analysis of bioenergy undertaken at the domestic level.

Contact Matti Parikka, matti.parikka@energimyndigheten.se

- *Review the collection and analysis of statistics to provide more accurate data on current and future biomass resource demands.*

Actions taken:
In 2008 the Swedish Energy Agency carried out a review of existing biomass related energy statistics[9] . The review identified a number of problems and weaknesses with the current official statistics in this field and the review resulted in a plan of how the statistics could be developed. The Swedish Energy Agency is responsible statistical authority for the official energy statistics and has since the review was published in 2008 carried out several development activities which aim to improve the quality of statistics, improve the level of details in published official statistics, such as national energy balances, and improve the possibilities for statistical analysis.

The Swedish Energy Agency also has an on-going collaboration in this field of statistics with The Swedish Forest Agency. This collaboration aims to improve the statistics on production of wood fuels and knowledge of the origin of the wood fuels used in the Swedish energy system. Further statistical development activities in this statistical area have been made in renewable proportion of municipal waste.[10]

Contact Jonas Paulsson, Jonas.paulsson@energimyndigheten.se

[9] The Swedish Energy Agency 2008, Förbättra biobränslestatistik – Förslag till åtgärder, ER 2008:27
[10] PROFU 2008, Analys av den förnybara andelen i avfall till förbränning med hänsyn till energiinnehåll

- *Review current policies supporting the production and importation of first generation biofuels and use life-cycle analyses to assess their contribution to greenhouse gas mitigation, and the costs per tonne of CO2 avoided.*

Actions taken:

The Renewable Energy Directive (2009/28/EC) with its binding criteria for sustainability for biofuels has since 1 January 2011been fully implemented in Sweden. The directive requires that biofuels reduce greenhouse gas emissions with at least 35% compared to the fossil fuels.

The Swedish Energy Agency has built up competence concerning first generation biofuels and has recently set up a new unit for dealing with regulatory measures and support on sustainability criteria.

Sweden also has tax exemption contributing to an increasing share of renewable motor fuels; only biofuels which fulfil the sustainability criteria will get the tax exemption. Many of the biofuels used in Sweden today have a higher reduction of greenhouse gases than 35%, the directive supports the use of biofuels produced from residues and waste. The directive also includes binding national target for the renewable energy share in transports which is set to 10%. The review of policies for Sweden is to a large extent coordinated within the European Union. The use of renewable energy in transports in Sweden is estimated to reduce the emissions with 0.9 Million ton/carbon dioxide equivalents per year[11]. This reduction corresponds to approximately 1% of Sweden's total emissions. The cost for this reduction is estimated to 3 SEK/kg carbon dioxide[12].

Several investigations were carried out by the Swedish Energy Agency on the topic. These investigations are for the most part governmental assignment; included as assignment at the Swedish Energy Agency annual regulation or are special assignments commissioned e.g. by the Ministry of Enterprise, Energy and Communications. More detailed information is available at the Swedish Energy Agency website: http://www.energimyndigheten.se/Yttranden-och-avrapporterade-regeringsuppdrag/.

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[11] Government office of Sweden, Sweden's First Progress Report
Submitted under Article 22 of Directive 2009/28/EC
http://ec.europa.eu/energy/renewables/transparency_platform/template_progress_report_en.htm

[12] Swedish National Audit Office, Biodrivmedel för bättre klimat - Hur används skattebefrielsen? (RiR 2011:10)
http://www.riksrevisionen.se/PageFiles/8575/Anpassad_11_10_Biodrivmedel_f%c3%b6r_b%c3%a4ttre_klimat.pdf

- *Encourage the use of ethanol, biodiesel and biogas where technically feasible, economical and positive for greenhouse gas mitigation.*

Actions taken:

There are a number of policies in place to increase the share of renewable motor fuels, see table 7, and sections 4-C and 4-G for more information.

Other Forms of Renewable Energy

- *Maintain the electricity certificate system and monitor the cost-effectiveness of other support schemes for renewable electricity, adjusting them, if needed, to reflect changes in the framework conditions for investing in new generating capacity.*

Actions taken:

In 2006 the Government decided to increase the target of the electricity certificate system and introduced a time limit for the right to receive certificates in order to prevent commercially viable older plants from exploiting the certificate system and creating unjustifiably higher costs for electricity consumers. Limitation of this qualifying period reduces consumer's costs for the electricity certificate system, which is important when the overall target objective of increased production is raised. Plants started up after 1 May 2003 are entitled to receive certificates for up to fifteen years, but in no case after the end of 2035.

In order to achieve the target of at least 50% renewable energy by 2020, the Government has put forward a number of proposals, including the further development of the electricity certificate scheme for renewable electricity generation. The previous target for new renewable electricity (i.e. to affect an increase of 17 TWh between 2002 and 2016) has been revised and a new target for an increase of 25 TWh by 2020 was adopted by the Parliament in 2010.

A binding agreement on a joint Swedish-Norwegian electricity certificate market was signed in 2011. The market started on 1 January 2012 and according to the agreement will run until 2036. The objective of the joint market is to increase the production of renewable electricity by over 26.4 TWh between 2012 and 2020, with both countries having equal ambition levels. This means that, in addition to the Swedish target of 25 TWh between 2002 and 2020, the additional production of 13.2 TWh of renewable electricity. A joint electricity certificate market, in which Norway joins the Swedish model, produces a larger market with a greater number of members, which is expected to result in improved competition through increased liquidity and more stable prices. The target for increased renewables

production can be achieved more cost-efficiently, as investments will be made where conditions are most favourable.

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4-C Renewables targets and progress

In 1990, Sweden's proportion of renewable energy amounted to 33%. By 2010, this had increased to 47.8%, the target being at least 50 % in 2020. Of the total renewable energy in 2009, 187 TWh, renewable electricity production and the industrial use of biofuels constituted the largest items. Of the total use of renewable energy, biofuels accounted for 57%. The increase in the proportion of renewable energy since the 1990s is due in large part to the use of biofuels in electricity and heat production and in the forest industry. Renewable energy in the transport sector accounts for a very small part of the total use of renewable energy. The share of renewable energy for heating and cooling was about 65% in 2010 and about 56 % for electricity.

The electricity certificate system will give Sweden an increase in electricity production from renewable energy sources. The goal is to increase the production of electricity from renewable energy sources with 25 TWh by the year 2020, compared with 2002. The system is intended to run until the end of 2035 and will help Sweden to achieve a more ecologically sustainable energy system.

Electricity production in the form of wind power, certain forms of hydro power, certain biofuels, solar energy, geothermal energy, wave energy and peat in CHP plants qualifies for electricity certificates. In 2010, electricity production qualifying for electricity certificates came to 18.1 TWh. The Renewable Energy Directive does not count peat as a renewable fuel. Electricity production from renewable energy sources in the electricity certificate system, excluding peat, came to 17.3 TWh in 2010.

Table 8: Renewable electricity production in the electricity certificate system, 2003-2010, GWh

	2003 May-Dec	2004	2005	2006	2007	2008	2009	2010
Hydro	964	1 968	1 799	2 019	2 195	2 607	2 442	2 611
Wind	456	865	939	988	1 432	1 996	2 490	3 486
Biofuels	4 218	7 671	7 926	8 594	9 049	9 599	9 766	11 163
Peat		545	634	556	580	834	871	792

Solar	0.004	0.006	0.005	0.02	0.019	0.129	0.212	0.275
Total	5 638	11 048	11 298	12 157	13 256	15 037	15 570	18 053

Sweden's target for renewable energy in the transport sector is the same as that of the EU, the share of renewable energy must, by 2020, constitute at least 10% of the total energy use for land transport. The preliminary share of renewable energy for transport in 2011 was 9,8% compared to 7,9% in 2010 (EU RES Directive calculation methodology[13]). The use of petrol decreased with 7% while the use of diesel increased with 4%[14].

Previously, the EU -directive 2003/30/EU set an indicative target of 5.75 % biofuels of the road transport energy use. Sweden's proportion of biofuels road transport amounted to 5.7% in 2010. Hence, Sweden was very close to reaching the EU target for 2010. The corresponding figure for 2009 was 5.4%.

The alternative motor fuels currently used for operating vehicles are primarily natural gas, biogas, ethanol and biodiesel. Natural gas and biogas are known as 'vehicle gas' and are mainly used as motor fuels for buses and passenger cars. Ethanol is used both as a low-admixture additive in petrol and as a component of fuels such as E85 and ED95. Biodiesel is used both in a pure form and mixed with diesel.

Ethanol as a low-admixture additive in petrol increased gradually during the early 2000s and has, since 2005, had an admixture level of 5% in almost all petrol on the Swedish market. Biodiesel (FAME) as a low-admixture additive in diesel became permitted from 1 August 2006 and has, since then, increased steadily. The statistics for 2010 show that there was an admixture of 5% FAME in just over 80% of all diesel delivered to the Swedish market.

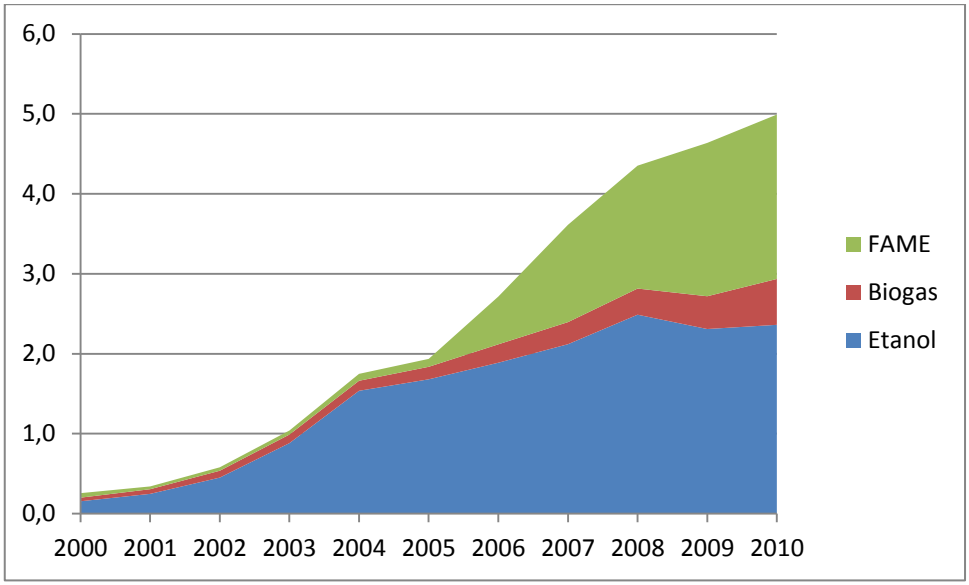
Vehicle gas consists of either pure biogas, pure natural gas or a mixture of the two. The proportion of natural gas in vehicle gas varies depending on where in the country it is sold; it is generally higher in areas covered by the natural gas grid. In terms of the total use of vehicle gas in 2010, its constituent proportion of biogas was just under 64%.

There has been a significant increase in the use of E85 during the last years. The vehicle taxation rules have made it favourable to purchase ethanol cars, which have resulted in quite large shares of ethanol cars in the new cars sales. Also, the tax exemption for ethanol as a motor fuel has made E85 a competitive fuel to

[13] The Renewable Energy Directive 2009/28/EC
[14] http://energimyndigheten.se/sv/Press/Pressmeddelanden/Sverige-nara-att-na-fornybartmal-i-transportsektorn/

gasoline. However, due to recent changes in vehicle taxation rules and the uncertainty of fuel prices, the E85 sales is expected to level out in the next few years.

Figure 4: Final energy use of renewable motor fuels, 2000–2010, in TWh



Sweden is expected to reach the target of 10 % renewable energy in transport already in the next few years. However, the current policies might not be enough to sustain these levels up to 2020.

A checkpoint will be conducted in 2015 in order to analyse the actual development of energy balance, cost and climate impact against the targets, as well as the state of knowledge regarding climate change. The checkpoint does not concern the fundamental policy direction but may lead to adjustment of policies and instruments.

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4-D Division of responsibilities

The Swedish Energy Agency is the central governmental body responsible for the main part of the authority functions within the energy area. Measures in the energy sector are managed by the Swedish Energy Agency.
www.energimyndigheten.se

Measures in the residential/building sector are managed by the National Board of Housing, Building and Planning www.boverket.se and the County Administrative Boards www.lst.se.

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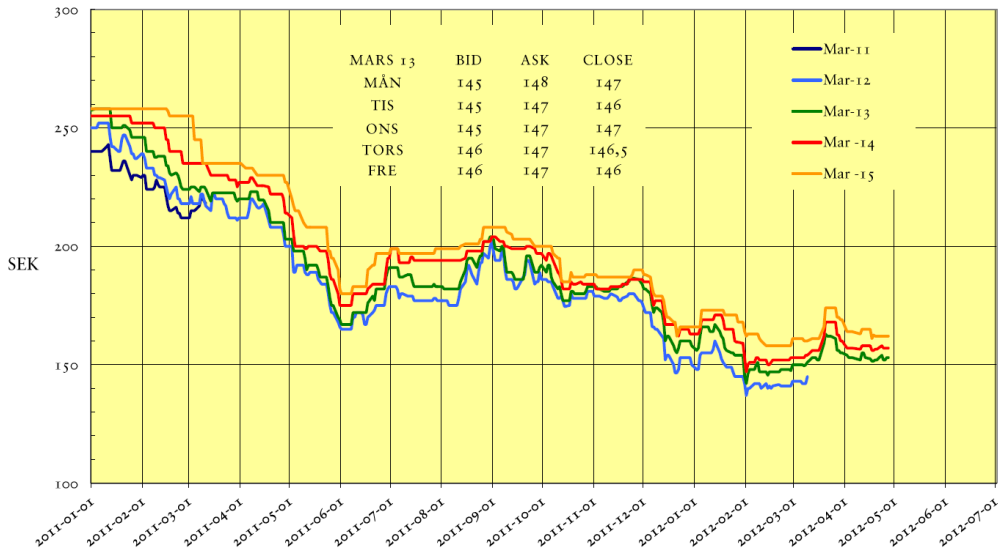
4-E Details on renewables promotion policy – electricity

Electricity certificates

Sweden introduced the Act Concerning Electricity Certificates (2003:113) in 2003 to increase the proportion of the country's electricity produced from renewable energy sources - solar power, wind power, hydro power and biofuels, as well as from peat in CHP plants. In 2009 the Bill 2009/10:133, to extend the electricity certificate system to the end of 2035, was adopted. Its objective is to increase the use of electricity from renewable energy sources by 25 TWh in 2020 compared to 2002. The system will run until the end of 2035. A binding agreement on a joint Swedish-Norwegian electricity certificate market was signed in 2011. The market started on 1 January 2012 and according to the agreement will run until 2036.

Under the system, electricity producers receive from the state a certificate for each MWh of renewable electricity that they produce. This certificate can be sold, to provide additional revenue over and above that from the sale of the electricity, improving the economics of electricity production from renewable energy sources and encouraging the construction of plants for the purpose.

The demand for certificates is created by a requirement under the Act that all electricity suppliers and certain electricity users are required to purchase certificates equivalent to a certain proportion of their electricity sales or use, known as their quota obligation. The size of this obligation changes from year to year, increasing the demand for renewable electricity and certificates. The price of certificates is determined by supply and demand, and can vary from one transaction to another. The figure below shows market prices as quoted by SKM, the leading elcertificate broker on the market. The trading is today mainly done through brokering but Nasdaq OMX recently announced that they are planning to open a trading platform for electricity certificates.



The cost of suppliers' certificates is included in the price of electricity paid by consumers. There is an exception for consumers that operate manufacturing processes that are electricity-intensive from buying certificates; the exception is entirely or partly due to how electricity-intensive the company is. The cost for electricity certificates paid by electricity consumers is expected to be 2,5-9 Swedish öre/kWh electricity (2,8-10,1 Euro/MWh) in the coming years which corresponds to levels so far.

Financial support to photovoltaics

A new financial support for the installation of solar cells was introduced 1 July, 2009. The support can be provided for all types of grid-connected photovoltaic systems, and for installations which started earlier than 1July 2009 and completed by 31 December 2012. The grant is up ton45 per cent of investment cost. SEK 60 million has been allocated for financial support to solar cells in 2012. For the period 2009 to 2011 a total of SEK 222 million was allocated. The target is that electricity production from solar cells in Sweden should increase with 2.5 GWh during the period 2009-2012.

Guarantees of origin

The Act on guarantees of origin for electricity (2010:601) entered into force on 1 December 2010. The purpose of the Act is to allow the end user to know the origin of electricity in a clear manner. Guarantees of origin are electronic documents which guarantee the origin of electricity. The guarantee of origin indicates the type of energy source that the electricity comes from and also in which plant the electricity was produced. Producers of electricity receive a guarantee from the state for each megawatt hour of electricity produced, which

can then be sold on the open market. Guarantees of origin are issued for all types of electricity production. It is the electricity producers and suppliers that are affected by the Act on guarantees of origin. Applications for guarantees of origin are still, at present, optional.

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4-F Details on renewables promotion policy – heat

The electricity certificate system indirectly increases the renewable share in heat production in CHP plants. Another important policy measure is a substantially lower CO_2-taxation, within EU-ETS, for heat production in CHP plants compared to heat production only, which improves the competitiveness of renewable heat. For more information see section 9S on CHP development.

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4-G Details on renewables promotion policy - transport/biofuels

Main drivers for biofuels policy

The main drivers for biofuels policy are to become less dependent on oil products and to decrease the emissions of CO_2 from the transport sector. Another aim, not directly related to biofuels, is to increase the overall energy efficiency in the transport system. The RES-D includes specific requirements concerning sustainability criteria for biofuels and bio liquids. According to the directive, these sustainability criteria have to be fulfilled in order for these fuels to be taken into account for fulfilling the binding goals. Only biofuels and bio liquids that fulfil the sustainability criteria may be taken into account for the fulfilment of quotas for renewable energy, or to be entitled to state aid for the use of these fuels. In Sweden, the fulfilment of the sustainability requirements is a condition in order to attain tax exemptions for the relevant biofuels and bio liquids, and to receive a (green) electricity certificate for certain bio liquids. The Swedish Energy Agency is the national agency responsible for implementing the sustainability criteria.

Biofuel obligations

Low blending limits have increased for ethanol (from 5 to 10%) and for biodiesel (from 5 to 7%). However, there is no obligation to blend biofuels into petrol and diesel. Also, the actual low blending depends on the excise duty, see below.

Table 9: Actual low blending levels 2007-2010 (number in parenthesis shows allowed level of low blending according to regulation)

Year	Biodiesel (%)	Bioethanol (%)	Biofuels
2007	4 % in 67 % of all diesel (5 %)	5 % in 93 % of all petrol (5%)	4.2%
2008	4.5 % in 76 % of all diesel (5%)	5 % in 94 % of all petrol (5%)	4.9%
2009	5 % in 81 % of all diesel (5%)	5 % in 95 % of all petrol (5%)	5.4%
2010	5 % in 80 % of all diesel (7%)	5 % in 96 % of all petrol (10%)	5.7% (target 5.75 %)

Excise duty reductions

The current limits of the tax exemption are 6.5% for ethanol, and 5% for biodiesel. Low blending above these levels is subject to the same tax as petrol or diesel. High blends, for example E85, ED95 and biodiesel (100 % RME) are subject to full tax exemption. Biogas as a transport fuel is also tax exempted.

The gasoline/diesel ratio in Sweden is closer to the North American average than the European average, largely due to tax differences. However, diesel is increasing its share rapidly due to fiscal incentives for new cars and an increasing demand for transportation of goods.

Table 10: Tax loss due to tax exemption of motor biofuels, 2007-2011, billion SEK

	2007	2008	2009	2010	2011
Tax loss, billion SEK	1.78	2.21	2.38	2.54	2.83

Fiscal incentives

In 2006 a carbon dioxide differentiated vehicle tax was introduced. This mainly provides guidance towards increased energy efficiency but has an element of tax relief for cars that can be run on alternative motor fuels.

With effect from 1 July 2009, new clean vehicles are exempted from vehicle tax for five years. A clean vehicle is a vehicle equipped with technology for operation entirely or partially on electricity, alcohol or gas, or a fuel-efficient petrol or diesel car with carbon emissions below 120 g/km. With effect from 1 January 2012, a super-green car rebate (cars with emissions below 50 g/km) was introduced. The size of the premium is SEK 40,000 for individuals and 35 per cent of the additional cost of producing a super-green car or a maximum of SEK 40,000 for legal entities.

With effect from 1 January 2011, the carbon dioxide differentiation of vehicle tax was increased from SEK 15 to SEK 20 per gram of carbon dioxide per kilometre,

making vehicles which have high carbon dioxide efficiency a more advantageous choice. From 2011, the vehicle tax for newly registered light goods vehicles, buses and motor caravans are also subject to carbon dioxide differentiation. The vehicle tax for heavy goods vehicles does not include carbon dioxide differentiation, but is levied by weight and exhaust class.

The benefit value of a company car is subject to income tax, and tax for this is also levied through the social insurance contributions paid by employers. Free motor fuel may also be part of a company car package. How these benefits are taxed, affects which cars are selected and how they are used. Benefit taxation is also reduced for clean vehicles.

Other measures stimulating the implementation of biofuels

On 1 April 2006, a law on the obligation to make renewable fuels available at filling stations came into place. According the law, filling stations with a certain sales volume must offer a renewable motor fuel in addition to petrol and diesel. Many local incentives for environmental cars exist, such as free parking and relief from congestion charges. Procurement rules for state authorities also include the demand for a certain proportion of environmental cars. Following the EU directive 2009/33/EC, from 1 July 2011, a new Act requires that the procurement or leasing of cars and public transport services take into account a vehicle's energy consumption and emissions during the entire period of use[15].
Two major research projects were completed in 2010, BEST and NILE. BEST was an EU-wide project in which the City of Stockholm and the Biofuel Region were participants, while many Swedish research groups were linked to the NILE project.

Three research programmes in the energy sector in Sweden include Bio4Energy, a consortium headed by Umea University, the Chalmers Energy Initiative, a centre for research on energy technology at Chalmers University, and STandUP for Energy, a consortia headed by Uppsala University focused on sustainable energy and electrical vehicles.

Research in the transport sector prioritises the production of renewable motor fuels and energy-efficient vehicles. The development of renewable motor fuels centres primarily on second generation biofuels in the form of ethanol, DME/methanol, biogas and synthetic natural gas through gasification (SNG),i.e. methane. The development of internal combustion engines is aimed primarily at reducing fuel consumption in passenger cars and heavy-duty vehicles as well as reducing harmful emissions. Research on electric drive systems is concentrated on

[15] Bill (2011:846), Lag (2011:846) om miljökrav vid upphandling av bilar och vissa kollektivtrafiktjänster

electric and hybrid vehicles, the distribution of energy for electric vehicles and on fuel cells. Development and commercialisation of hybrid vehicles has been intensified and now extended so that it also includes rechargeable hybrid vehicles.

Announced measures

The government plans to appoint a Committee with the responsibility to present concrete proposals on how to reach the target that by 2030, Sweden should have a vehicle fleet that is independent of fossil fuel.

On April 16 2012 the government announced a number of proposals aiming at an increased share of renewable energy in the transport sector.

Tax exemptions for biofuels will be regulated by law and not as earlier by governmental decisions giving specific companies tax exemptions for given volumes. The tax exemption on ethanol and FAME for low blending will be slightly decreased in 2013 since the current exemption problably by 2013 (as a result of increased taxrates on the fossil alternatives) will be higher than allowed by the EU state subsidy rules.

At the same time the vehicle taxation will be adjusted so that vehicles which have high carbon dioxide efficiency will be a more advantageous choice.

The government also declares that by 2014 a quota obligation system will be introduced in order to increased actual low blending of ethanol and FAME to the levels allowed by the Fuel Quality Directive (i.e. 10 percent ethanol in petrol and 7 percent FAME in diesel).

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5. Natural Gas

Contact Energy Markets Inspectorate

5-A Policies overview including major changes since previous IDR

The new climate and energy policy adopted by Parliament in the beginning of 2009 covers a wide range of climate and energy-related topics including policies on natural gas and oil.

5-B Previous IDR recommendations

The government of Sweden should:

- *Improve conditions for competition in the natural gas market by ensuring effective unbundling of network operations from the utilities' other activities; establishing a secondary market for gas transmission capacity; considering ex ante regulation of network tariffs; and ensuring regulatory flexibility for developing international gas connections.*

Action taken:

The legal framework laid down in the third Gas Market Directive has been implemented in the Swedish national legislation by adjusting the Swedish Natural Gas Act (2005:403).

Sweden has opted for ownership undbundling.

The Swedish natural gas market is totally dependent on import from or through Denmark via one single pipeline.The interconnection point (Dragör) is situated in Denmark and operated by the Danish TSO, Energinet.dk. The total import capacity of the Swedish gas transmission grid is currently approximately 22 TWh/year. With a total consumption of approximately 19 TWh/year there is currently neither congestion as regards to entry capacity, nor any congestion within the Swedish gas transmission grid itself. Due to the lack of congestion, no secondary market has been established so far. The Swedish gas transmission grid contains a significant volume of unused capacity (linepack), approximately 20 – 25% of a winters day consumption. This line-pack flexibility is used for maintaining the short term balance in the Swedish natural gas transmission grid and is utilized in a way that the need for the TSO to take balancing actions is very low.

Available flexibility is to be distributed between the balance responsible parties, daily before the day of delivery, in accordance with the average monthly capacity needs of the end users. The distribution is based on average monthly capacity needs per balance responsible party. The calculation is done by the network owners for each of the networks respectively. After this the network owner will report the average monthly capacity per balance responsible party to the TSO.

The Swedish Energy Markets Inspectorate is, as required in article 39 of the Gas Market Direktive appointed as National Regulatory Authority (NRA) and is responsible for ensuring access to and regulating tariffs and methodologies for gas transmission grid, gas distribution networks, storage and LNG facilities. The methodologies are subject to ex-ante approval by the Energy Markets Inspectorate according to art. 41.6. and 8.[i16] Gas Market Directive. The Natural Gas Act, being adjusted to the Gas Market Directive, also requires the tariffs to be fair and non-discriminatory. The regulation of the fairness of the tariffs is at present performed ex-post. The Energy Markets Inspectorate has however proposed to apply an ex-ante regulation of tariffs. This legislation is expected to enter into force in 2013 and most probably improve investment conditions in the Swedish gas transmission grid as well as the Swedish gas distribution networks.

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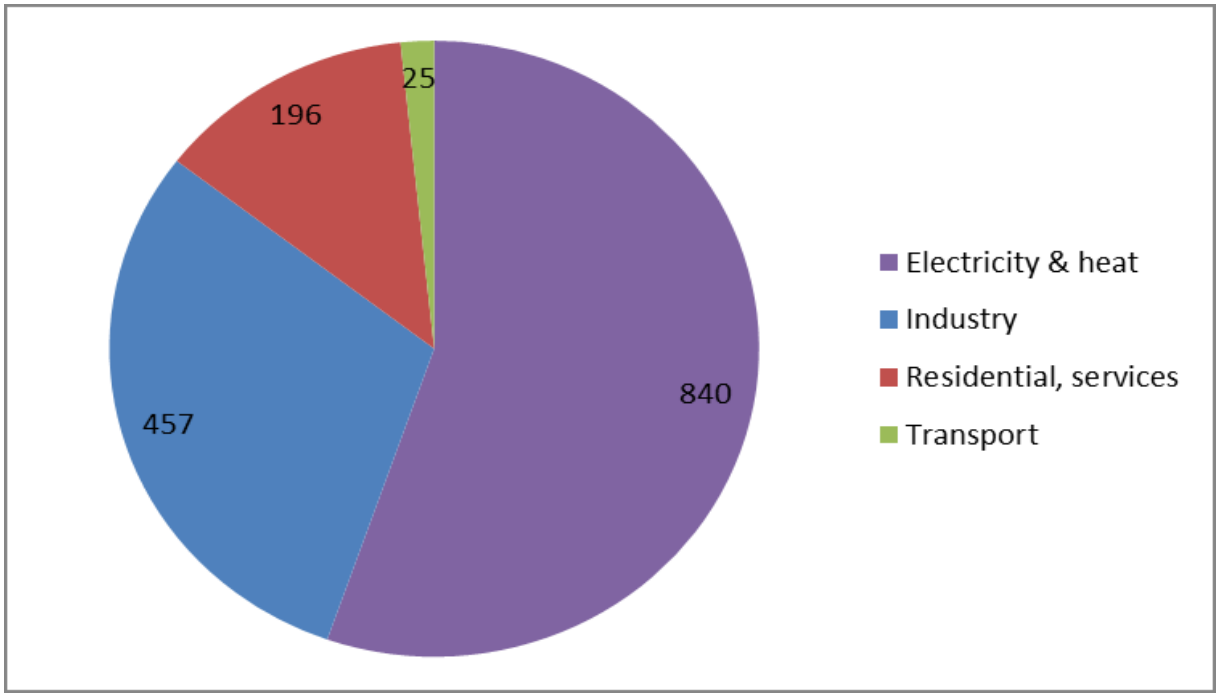
5-C Demand

In 2010 a record volume, 1 600 MNm^3 (1.6 Mtoe), of natural gas was imported. The increase in gas consumption was mainly due to the start of a large gas-fired CHP plant in 2009 and cold weather during 2010. In 2011 the volume was down to 1 230 MNm^3 mainly due to warm weather.

Natural Gas Consumtion per sector 2010 [ktoe]

[16] Parliamentary decision on ex-ante regulation of LNG scheduled for 24th of May 2012



There are approximately 37 000 customers connected to the gas system. The Swedish gas market is characterized by a small number of customers, CHP- and district heating-units together with larger industry, using a large share of the gas and a large number of house hold using a small share of the gas. In the first mentioned group, 60 large users take approximately 80%t of the gas. The number of households amount to 34 000 of which approximately 50% are single family houses using gas for heating purposes and 50% use gas for cooking purposes only. These consumers take 2% of the gas.

Projections for 2020 has indicated a decrease in demand for natural gas, which can be explained by a decreased gas demand in the energy conversion sector. However, the estimated amounts are a result of an economic optimisation model, which is heavily dependent on e.g. projected gas prices. The results should therefore be interpreted with caution. Consumption in industry is expected to increase somewhat, mainly because of economic growth in gas-consuming industrial sectors.

5-D Peak demand and seasonality

There is a substantial seasonality with regard to the demand. Peak day demand during winter period is approximately 8 MNm^3 per day. This is more than 200% of the average demand during the year. During the summer period the demand could be as low as 30% of the average demand. The difference is mainly a result

of the large share of the market of CHP- and district heating plants. These plants do normally not use natural gas during the warmer part of the year.

5-E Demand side policies

There is no data available regarding the number of interruptible natural gas customers or customers having the possibility to switch fuel. However, the large CHP-plants, district heating plats and some of the larger industries have a technical possibility to use alternative fuel i.e. oil. The system balancing administrator has the powers to order the proprietor of natural gas networks to restrict or discontinue the transmission or distribution of natural gas to customers.

5-F Imports and Exports

There is no extraction of natural gas in Sweden and the entire volume of consumed natural gas is imported from or via Denmark through the interconnection point in Dragör.

On an average winter day the entire Swedish market is supplied by the import from Denmark. The storage facilities in Denmark are used to handle the seasonal swing in Sweden. There is a large flexibility in line pack of about 25% of a winter's day´s consumption for the whole market.

There are gas infrastructures not connected to the Swedish natural gas system. In the port of Nynäshamn, a city south of Stockholm, there is a LNG receiving terminal. The LNG imported is sourced in Norway. There are also plans for a LNG receiving terminal in Lysekil on the Swedish west coast adjacent to the existing Preem refinery. The LNG to this terminal will also originate from Norway.

5-G Production & Reserves (If applicable)

There is no production of natural gas in Sweden. However, small volumes of biogas with a quality equal to natural gas are injected in distribution systems.

There have been exploration activities adjacent to the Swedish gas system regarding unconventional gas. However, the activities were not followed by production due to poor economics. There are other exploration activities in parts of Sweden although distant from the Swedish gas system.

5-H Long-term contracting

There is no information available on possible long term gas supply contract.

5-I Transit

Sweden is situated at the far end of the European gas system and there are no transit flows.

5-J Industry structure

As mentioned above in question 5-F, there is no extraction of natural gas in Sweden.

Currently two entities are performing the TSO function in Sweden. The state owned utility Svenska Kraftnät (also TSO for the electricity market) is assigned as system balancing administrator for gas. Swedegas AB is the owner and operator of the transmission grid and the only existing storage facility in Sweden. The company is owned by the private investment group EQT.

Until autumn 2011 there was a third party sharing the TSO role but as a result of the sale of their part of the Swedish gas transmission grid to Swedegas on the 30th of September 2011, E.ON Sverige gas AB can no longer be considered as a TSO. The acquisition by Swedegas comprised of a 230 km high-pressure gas transmission network including 32 metering and regulation stations.

Svenska Kraftnät is responsible for the short term balancing administration which among others includes nomination, matching and allocation of gas. Both the daily balancing settlement and the final monthly and financial settlement are carried out by Svenska Kraftnät. Swedegas is currently responsible for technical operation and the capacity allocation within the Swedish gas transmission grid as well as daily maintenance and enlargement of the Swedish gas transmission grid. A committee recently proposed the transfer of the present system balancing administration from the state agency Svenska kraftnät, to the private company Swedegas AB, in order to create an efficient market with a strong TSO better capable of ensuring the security of supply.

The proposal is at present under consideration within the ministry. Further information in English can be found in the committee´s proposal SOU 2011:46 at http://www.regeringen.se/sb/d/108/a/168766.

On the wholesale market there are currently two companies operating (DONG Energy AB and E.ON Gashandel Sverige AB while the retail market is slightly more competitive with five active suppliers (of which E.ON Gashandel Sverige AB, Dong Energy AB and Göteborgs Energi AB have approximately 90% of the market)

There are currently five DSO's existing on the Swedish natural gas market, E.ON Gas Sverige AB, Göteborgs Energi Gasnät AB, Lunds Energi AB, Varberg Energi

AB and Öresundskraft AB altogether owning 2600 kilometres of pipelines. Except E.ON Gas Sverige AB are all the DSO's owned by municipalities.

5-K Map (If necessary, please update a map in Gas Information Book/IEA)

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Table 11: Map of the Swedish Natural Gas Network

5-L Pipeline Infrastructure and access

The Swedish gas transmission grid is about 620 km long and the gas distribution network consists of approximately 26.000 km of pipeline and one small storage facility (Skallen) which has a very limited capacity and is not meant for seasonal

equalisation of natural gas consumption but to equalise short term consumption peaks.

No major investments in new pipelines are currently planned.

According to Chapter 2 §1 of the Natural Gas Act, the Swedish Government has the discretionary powers to grant a licence for the building and operation of a transmission pipeline, a storage or an LNG facility. The application is however sent to the Energy Markets Inspectorate, which will prepare the application ending up in a recommendation to the Swedish government whether to grant a licence or not. Subject to environmental and planning provisions, a licence can only be granted if it is suitable from a public point of view and awarded a suitable applicant. Distribution pipelines are not subject to such a procedure for obtaining licences under the Natural Gas Act. The same applies for natural gas facilities situated at industry sites, which are not connected to the natural gas grid.

The Natural Gas Act lays down an obligation for system operators to grant unrestricted third party access. There are also provisions on derogations according to article 36 Gas Market Directive. No such derogation has been granted.

The interconnector between Denmark and Sweden has a firm capacity of 6 MNm^3 per day. Actual information about the flows can be found on the following website **http://www.swedegas.se/marknad/dagens-naturgasmarknad/gas-flow**

5-M Storage Infrastructure and access

The LRC (lined rock cavern) storage in Halmstad area is connected to the Swedish natural gas system. The working gas volume amounts to 8.75 Mm^3. Maximum withdrawal capacity is 1.0 Mm^3/d. As the working gas volume is small the storage is mainly used for peak shaving. The storage is subject to regulated third party access. There are no plans for additional storage capacity in connection to the Swedish gas system.

The Nynäshamn terminal, mentioned in 5-F and N, has a LNG-storage capacity of 9 000 ton. Permissions see section 5-L

5-N LNG Infrastructure - and access

See also under 5 F.
There is a LNG facility located at the site of the Nynäshamn harbour, without any pipeline connection to the natural gas grid. Thus, the facility is not subject to the provisions of third party access.

5-O Market overview

The legal framework laid down in the third Gas Market Directive has been implemented in the Swedish national legislation, the Natural Gas Act (2005:403). Further initiatives will mainly follow from the ongoing work on the development of network codes. In addition to that a committee recently proposed the transfer of the present system balancing administration from the state agency Svenska kraftnät to the private company Swedegas AB.

The proposal is at present under consideration within the ministry and further information in English can be found in the committee´s proposal SOU 2011:46 at http://www.regeringen.se/sb/d/108/a/168766.

E.ON Gashandel Sverige AB and Dong Energy AB are the two companies that sell natural gas on the Swedish wholesale market. Dong Energy is 73% owned by the Danish state, while E.ON Gashandel Sverige AB is owned by E.ON. AG. There are no figures available on their respective market shares in 2010, although there is no indication that there have been any major changes since 2006. In 2006, E.ON sold at that time around 5.3 TWh on the wholesale market and had a 48% market share. However, this figure does not take into account that a part of this volume is sold to other companies in the E.ON Group, who in their turn have resold the natural gas to end-users. In 2011 the sold volume of natural gas was approximately 19 TWh.

As described under 5 C the Swedish natural gas market has roughly 37 000 customers and is characterized by a small number of customers, CHP- and district heating-units together with larger industry, using a large share of the natural gas and a large number of house hold using a small share of the natural gas. In the first mentioned group, 60 large users take approximately 80% of the natural gas. The number of households amount to 34 000 of which approximately 50% are single family houses using natural gas for heating purposes and 50% use natural gas for cooking purposes only. These consumers, mainly in the cities of Gothenburg and Malmö, take 2% of the natural gas.

In 2010, 266 households switched natural gas supplier, a 6.6% decrease over the previous year. The total number of switches continues to remain at a low level and is equivalent to almost 1% of the total number of domestic customers. The equivalent figure for non-domestic customers was 172, or just over 4.7% of all non-domestic customers.

5-P Regulatory Institutions

The Swedish Energy Markets Inspectorate is appointed as National Regulatory Authority (NRA) according to article 39 of the Gas Market Directive and is

responsible for ensuring access to and regulating tariffs and methodologies for the gas transmission grid, gas distribution networks, storage and LNG facilities.

The Swedish Energy Agency is responsible for the security of supply of energy. The Agency is appointed as Competent Authority under Regulation (EU) 994/2010. Both regulatory authorities are independent from the Ministry of Enterprise, Energy and Communications .

5-Q Pricing Policy

The tariffs for transmission, distribution and LNG[17] are regulated by the Energy Markets Inspectorate. Retail prices are set by the market and not subject to regulation.

5-R Subsidies and incentives

The price for natural gas is market based and the price on transport of gas is regulated. Subsidies are not applied.

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5-S Natural gas security

The Swedish Energy Agency is the Competent Authority according to regulation EU 994/2010. Please see also IEA Emergency Response Review Questionnaire, delivered to the IEA 5 March 2012.

[17] Parliamentary decision on ex-ante LNG scheduled for 24th of May 2012

6. Oil

Contact Michaela Sahlin, Michaela.sahlin@energimyndigheten.se

6-A Policies overview including major changes since previous IDR

The new climate and energy policy adopted by Parliament in the beginning of 2009 covers a wide range of climate and energy-related topics including policies on natural gas and oil.

6-B Previous IDR recommendations

The government of Sweden should:

- *Continue efforts to reduce dependence on oil, increase the efficiency of oil use and reduce CO2 emissions from its use.*

Action taken:

Sweden has come to the point that oil is hardly ever used for heating and electricity production, only for extremely cold weather conditions. In the transport sector Sweden has reached about 7.3-8 % renewables in 2010, and the target is 10 % to 2020.

In order to reduce dependence on oil the industry plans to diversify its energy sources with LNG and also with natural gas consumption. For efforts in the transport sector see section 4-G.

6-C Demand

Table 12: Oil consumption in Sweden 2006-3020, Twh

	2006	2007	2008	2009	2010
Transport (domestic)	86	86	84	82	88
Industry	17	16	16	12	14
Residential and services	16	15	14	13	14
Total	119	117	114	107	116

Oil represented 10 % of the total energy use in industry in 2010. Consumption of oil and other fuels declined sharply during the recession, but oil use increased again in 2010.

Availability of particular energy carriers and the application of various policy instruments have affected the relative prices of different energy carriers, resulting in a transition from oil to electricity, district heating and biofuels. In 2010, the total use of oil products in the residential and services sector amounted to 14 TWh, a reduction of 65 % since 1990.

Table 13: Use of heating oil in the residential sector, 2006–2010, TWh

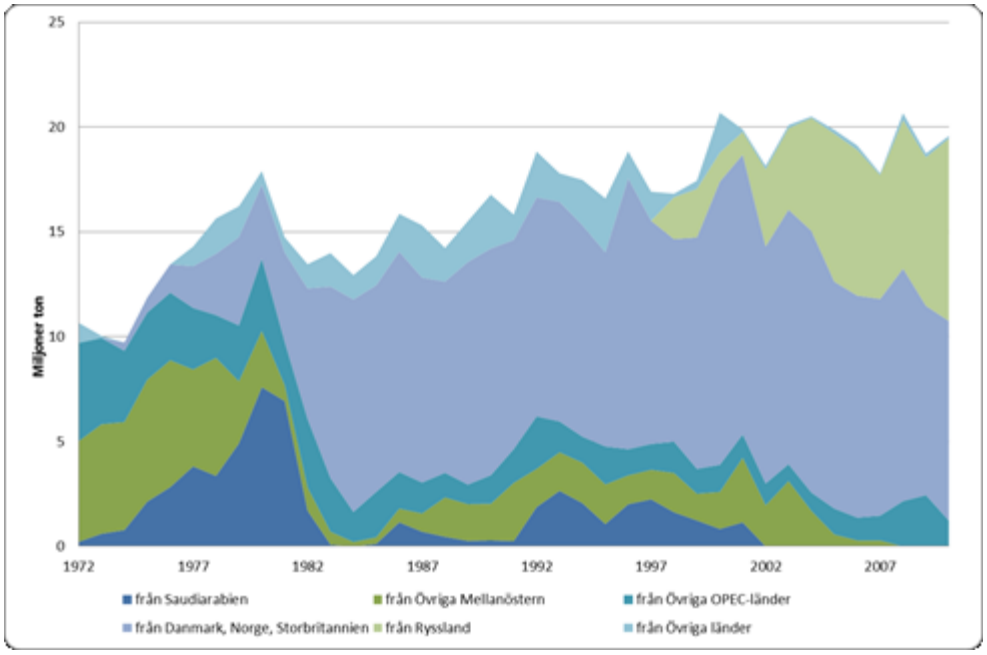
	2006	2007	2008	2009	2010
Residential	4,5	3,3	2,5	1,9	1,6

6-D Imports and exports

Sweden is not an oil producing country and is therefore completely dependent on imports. However, the Swedish refineries produce more oil products than the domestic demand and Sweden has been a net exporter of refined oil products for the last 20 years.

Sweden's import of crude oil in 2010 was just over 19 million tonnes, which may be compared to the net export of refinery products of 5.1 million tonnes, see figure 6 below. About half of Sweden's total import of crude oil comes from the North Sea, primarily from Norway and Denmark. In addition, the proportion of crude oil imported from Russia has risen greatly in the last decade, amounting to 44% of the total import of crude oil in 2010.

Swedish import of crude oil by country of origin, 1972–2010, in million tonnes



6-E Production & Reserves (If applicable)

Not applicable for Sweden.

6-F Industry structure

The following merges have taken place since the last In-depth review Sweden:

- Statoil has acquired most of the Norsk Hydro assets in Sweden.
- Statoil has acquired most of the JET station net in Sweden, except from 40 sites that St1 has acquired.
- St1 Sverige AB has acquired some (120) of the Norsk Hydro assets (Automates and a few service stations)
- St1 has acquired AB Svenska Shell including its subsidiary Shell Raffinaderi AB, the companies are from the 1 December 2010 renamed St1 Energy AB and St1 Refinery AB.

6-G Transport fuels

Table 14: Total energy use for transport, 2007–2010, TWh

Year	Petrol	Diesel and gasoil	Electricity	Bunker oils	Medium and heavy fuel oil	Aviation fuels	Natural gas and LPG	Renewable fuels	Total
2007	44,5	38,7	2,9	24,6	0,5	11,3	0,3	3,6	**126,3**
2008	41,8	39,2	2,7	24,2	0,4	11,6	0,3	4,3	**124,6**
2009	40,9	38,0	2,4	25,2	1,0	10,5	0,3	4,6	**123,0**
2010	39,7	44,3	3,0	23,3	1,7	10,3	0,3	5,0	**127,6**

Total energy use for transport in 2010 amounted to about 128 TWh. Of this, domestic transport used about 96 TWh, and foreign transport (including bunkering for foreign maritime traffic and air transport) used about 31 TWh. In 2010, renewable motor fuels (ethanol, FAME and biogas) supplied about 5.7 % of the energy use for road traffic.

Diesel accounts for 46 % of domestic energy use and petrol accounts for 41 % in transport fuels. The share of diesel has increased rapidly during the past years. One reason for this is fiscal incentives for new cars. In 2006 a carbon dioxide differentiated vehicle tax was introduced. This mainly provides guidance towards increased energy efficiency.

Between 1st April 2007 and 30th of June 2009, there was a 10 000 SEK grant for private purchasers of new clean vehicles. 1st July 2009, this scheme was replaced by tax exemption for five years for new clean vehicles. A clean vehicle is a vehicle equipped with technology for operation entirely or partially on electricity, alcohol or gas, or a fuel-efficient petrol or diesel car with carbon emissions below 120 g/km. A large share of new clean vehicles consists of fuel-efficient diesel cars. This development is likely to continue. The EU regulation for CO_2 emissions for new cars (max 130 g CO_2/km in 2015) also favours diesel cars (due to the higher efficiency of the diesel engine compared to the gasoline engine).

The increasing demand for diesel is also due to the fact that the demand for transport of goods is increasing. Also, there is an increasing amount of duty vehicles running on diesel instead of petrol.

Table 15: Stock and share of new car sales of petrol and diesel cars

	2005	2006	2007	2008	2009	2010	2011
Stock of petrol cars	**3 905 083**	**3 879 605**	**3 804 987**	**3 699 225**	**3 607 248**	**3 479 607**	**3 442 549***
Share of petrol cars in new car sales	0,86	0,70	0,54	0,35	0,36	0,33	0,33

Stock of diesel cars	217 934	260 757	351 897	416 822	484 083	606 570	776 706*
Share of diesel cars in new car sales	0,10	0,20	0,31	0,36	0,41	0,51	0,60

*Preliminary statistics

6-H Pricing Policy

No changes since the previous review.

6-I Subsidies and incentives

No changes since the previous review.

6-J Oil security

Civil Emergency Planning/Crisis Management in Sweden is since 2009 the responsibility of Swedish Civil Contingencies Agency, MSB.

The Swedish structure for civil emergency planning is coordinated by the MSB, which holds the mandate for a holistic and all hazards approach to emergency management. This includes the entire spectrum of threats and risks, from everyday accidents up to major disasters.

On 12 June 2009, the EU adopted the Oil Storage Directive presented in 2008. The Directive is to be transposed no later than 31 December 2012. The new directive will mean that the current Swedish legislation for oil storage (LBOK) has to be revised.

7. Coal

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7A-A Policies overview including major changes since previous IDR

No major changes since the previous IDR in policy affecting coal and its competitiveness.

7A-B Previous IDR recommendations

No recommendations regarding coal were issued in the previous IDR.

7A-C Demand

No major changes in coal demand since the last IDR.

Coal use in Sweden has been relatively stable for many years. The use of coal in Sweden is very limited compared to other countries, approximately 3 million ton per year. Most of the coal (roughly two thirds) is coking coal used in industry process and not primarily for energy purposes. Iron and steel producer SSAB (Svenskt Stål AB or Swedish Steel) is the dominant importer of metallurgical (coking) coal and coke, and is the only producer of coke. It has two plants, in Luleå and Oxelösund, and they are connected to the municipal district heating network. The remaining one third of the coal is primarily energy coal used in industry and in a few CHP.

Coal in Sweden is mainly used in industrial processes

Industry uses energy coal, coking coal, coke and smaller quantities of other coal products such as graphite and pitch. Coke is essentially pure carbon, produced from coking coal in coking plants. The country's two coking plants also produce coke oven gas. Coke oven gas is used for heat and electricity production in iron and steel works and in the district heating sector. Coke is used in the iron and steel industry to remove the oxygen from iron ore and also inputs energy into the process. In the blast furnaces, some of the coke's energy content is transferred to blast furnace gas, which is used in the same way as the coke oven gas. In addition to coking coal and coke, energy coal is also used in industry, primarily in the iron and steel industry, mining industry and cement industry.

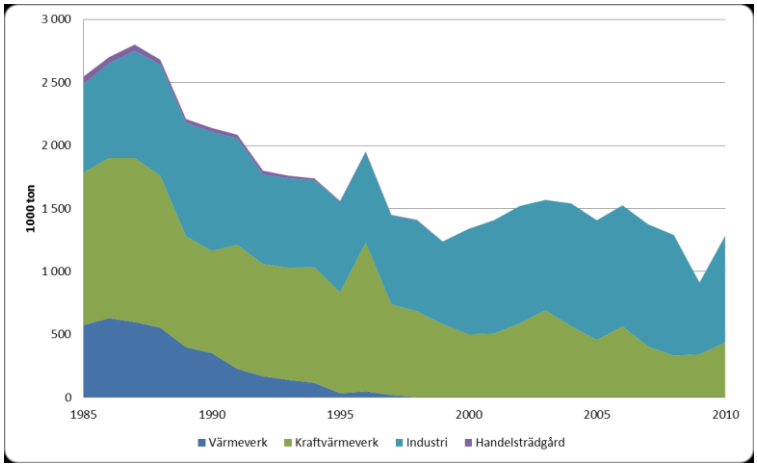
In 2010, industry in Sweden had a consumption of 1.8 million tonnes of coking coal and 0.8 million tonnes of energy coal. These amounts correspond to 9.8 TWh

of coking coal and 6.4 TWh of energy coal. Coking coal is used, as previously described, to produce coke, coke oven gas and blast furnace gas. Consumption is in 2010 up on more normal levels after the dip in 2009, which is explained by the global recession and financial crisis.

Coal consumption has declined in the Swedish district heating sector

The consumption of coal in the Swedish district heating sector declined greatly in the 1990s following the introduction of the carbon dioxide and sulphur taxes. This coal has been replaced by biofuels (biomass). Some CHP plants, however, still use coal to a certain extent, partly because the taxation rules for CHP production are not as stringent as for pure heat production. This difference in taxation aims to increase the competitiveness of CHP plants as opposed to plants which only produce electricity or heat. In 2010, the consumption in the district heating sector for the production of electricity and district heating was equivalent to 3.3 TWh of energy coal and 2.0 TWh of coke oven and blast furnace gas.

Figure 5: Consumption of energy coal in Sweden, 1985–2010, in 1000 tonnes



7A-D Production & Reserves (If applicable)

Not applicable for Sweden.

7A-E Imports and exports

All primary coal is imported. Coke is produced in Sweden, from imported coking coal.

In 2010, coking (metallurgical) coal came predominantly from Australia, the United States and Russia, much the same as during the previous IDR. The energy coal was imported mostly from Latvia, Russia and Poland.

7A-F Industry structure

All primary coal is imported. The coal is primarily used in the iron and steel industry and to a lesser extent in the cement, mining and pulp and paper industry, and in the energy sector in a few combined heat and power plants.

Iron- and steel producer SSAB in Luleå and Oxelösund is the dominating importer of metallurgical coal and the only producer of coke. SSAB is listed on the stock exchange. Cementa is the dominating cement producer with foreign (German) ownership. LKAB mining (iron ore products) is 100 % government owned. Two of the major CHP plants located in Västerås and Stockholm use coal as fuel. The plant in Västerås has municipal ownership, while the plant in Stockholm is owned by the municipality and Fortum together.

7A-G Subsidies and incentives

There are no coal production or consumption subsidies.

7A-H Coal Security

There are no special policies for coal security and crisis management. The Act for holding stocks in Sweden has been suspended.

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7A-I Clean Coal Technology

All coal-fired power plants in Sweden are combined heat and power plants; hence they have relatively high efficiency. Sulphur tax, NOx-fee and environmental licensing procedures are specific policy measures with the purpose to reduce emissions.

Due to the low carbon use in the energy sector, Sweden does not have any research programme on Clean Coal Technology.

8. Carbon Capture and Storage (CCS)

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8-A Policy Overview

Sweden transposed the CCS directive in a formally correct way without enabling CCS into Swedish legislation in 2011. Presently the legislation is under process of amendment. All the enabling measures in the CCS directive are intended to be covered by amendments to a number of Swedish laws related to environmental protection, continental shelf, economic zone and rights-of-way (ROW) for pipelines. The new enabling legislation is intended to come into effect by 4 January 2013.

8-B CCS projects

Below is a summary of the CCS projects that Sweden is participating in or has recently participated in. Sweden has neither any large-scale demonstration projects nor any pilot or test projects for CO_2 storage. However, Sweden is involved in some pilot-scale CO_2 capture projects.

Pilot-scale CO_2 capture projects

Chalmers University of Technology has pilot-scale test units for carbon capture in the form of oxyfuel combustion and chemical looping combustion. The university has a long experience of experimentally based research on:

- **Oxyfuel combustion for carbon capture with a unique 100 kW oxyfuel pilot unit.** The research activities are carried out together with Swedish industry and international partners, both in academia and industry. Several of the oxyfuel activities are linked to the Swedish utility company Vattenfall and to its 30 MW pilot testing plant in Germany. The pilot testing at Chalmers is also a part of the CCS development within the EU. In all, some 10 projects have been carried out with direct funding from the Swedish industry as well as in international consortia, with a total funding from Sweden of some EUR 5 million.
- **Chemical-looping combustion (CLC) of gaseous, liquid and solid fuels for carbon capture.** This involves equipment for laboratory studies of oxygen carrier materials, as well as four chemical-looping combustor units, the largest being a 100 kW unit for solid fuels. Funding of CLC research involves a total of more than EUR 10 million in more than a dozen projects, of which a significant part has come from seven EU projects.

CO_2 Storage projects

26 March 2012 the Swedish Energy Agency took the decision to fund two CO_2 storage projects in the Baltic Sea Region.

- The project **CCS in the Baltic Sea Region** was initiated by representatives from the Swedish industry. The project aims to enhance competence within CCS in order to support the efforts of the Swedish industry to sustainably reduce carbon dioxide emissions. The vision includes a future, common infrastructure for transport and storage of carbon dioxide in the Baltic Sea region. The focal point is the verification of the geological opportunities for sequestration of carbon dioxide in the deep sandstone formations under the southeast Baltic Sea. Complementary work packages aim to describe the current knowledge base about environmental consequences, societal, legal and fiscal aspects as well as the requirements for transport infrastructure. The project will be executed in close cooperation with the Finnish R&D program CCSP.
- The project **SwedSTORECO2** is a feasibility study for how to best proceed to build a test site in Sweden for CO_2 storage. The ultimate aim is to have a working test site on land where CO_2 is injected (up to 100 000 tons) into geological formations that are also present off shore. The feasibility study includes fluid flow modelling, cost assessment of drilling and injection operations, development of a monitoring strategy, identification of CO_2 sources, contacts with other CO_2 storage projects and assessment of the total storage capacity of Sweden. The project will be carried out by researchers at several universities.

International projects

Swedish industry and academia are involved in several international projects on CCS. The projects described below are relevant for the implementation of CCS in Sweden.

- The project **Assessing the Potential of Implementing CO_2 Capture in an Integrated Steel Mill** was developed by IEAGHG in collaboration with the Swedish company Swerea MEFOS AB. The project was initiated in January 2010, with co-funding from the Swedish Energy Agency, SSAB, LKAB and the member companies of Swerea MEFOS. The primary goal of this project is to specify a conceptual reference integrated steel mill producing hot rolled coil, and evaluate the cost and performance of the plant with and without CO_2 capture.

- The project **CCS in the Skagerrak/Kattegat region** is a Nordic CCS project partly funded by the EU, which Sweden has participated in. The project was initiated in June 2009 and completed in December 2011. The project assessed the prospects for CCS from industries and power plants located in the Skagerrak region, which comprises northern Denmark, the southeast coast of Norway and the west coast of Sweden. The project was cooperation between universities, research institutes and industries in the region.
- **MUSTANG** is a four-year large-scale integrating project funded by the EU FP7 that spans from 2009 to 2013, under the coordination of the Uppsala University, Sweden. The MUSTANG consortium comprises 19 institutions. It aims at developing guidelines, methods and tools for the characterisation of deep saline aquifers for long-term storage of CO_2, based on a solid scientific understanding of the underlying critical processes. Numerical models will be developed for analysing CO_2 injection and storage and then applied at a number of test sites representing different geological settings and geographical locations in Europe. One of the potential test sites is located in south-western Scania in Sweden.
- **The Top-level Research Initiative (TRI)** is the largest joint Nordic research and innovation initiative to date. The initiative aims to involve agencies and institutions in the Nordic region, and promote research in order to make a Nordic contribution towards solving the global climate crisis. The following CCS studies have been initiated in the TRI.
    - The project **Potential for carbon capture and storage (CCS) in the Nordic region** aims to give an overview of the potential for applying CCS in the Nordic countries. The realistic potential of CCS in the region has been evaluated by taking into account existing and future energy systems and policies, emission sources, potential storage sites, technological, economic and political constraints as well as public acceptance. Special attention has been given to identifying promising regional CCS solutions that would have a significant CO_2 emission reduction potential and could possibly involve cooperation between Nordic countries with synergic benefits for these.
    - **NORDICCS** is a project for boosting CCS deployment in the Nordic countries by creating durable networks, encourage innovation, and develop joint actions and processes to increase industry-driven innovation within CCS. NORDICCS is carried out within the framework of Nordic Innovation, which is a Nordic

institution working to promote cross-border trade and innovation. Chalmers University of Technology, the Swedish Environmental Research Institute (IVL) and the Geological Survey of Sweden (SGU) participate in the project together with partners from the five Nordic countries.

- The project **CCS in the Nordic countries in a renewable/climate neutral future (2050) - Overview of possible future developments and advice for funding** aims to evaluate the energy picture over time with more renewable energy in the Nordic region as well as the role of CCS in becoming climate neutral by 2050. The focus is therefore less on the technology and more on the overall energy picture, realism of cutting different emission sources and possible contributions of CCS in the different Nordic countries given that the countries are using much more renewable energy.

8-C Storage Potential

Existing information regarding geological storage of CO_2 in Sweden is limited to work performed by the Geological Survey of Sweden. Their work including an inventory regarding the possibility of finding suitable places for storage of CO_2 in the Swedish bedrock was presented in a comprehensive report in 2011 (SGU, Rapporter och Meddelanden 131, 2011). In addition to this report, information on the storage potential in Sweden is also found in reports from Elforsk AB (id. no. 2008:84) and the Swedish Energy Agency (2010, id. no. ER 2010:36). The documentation is, however, only available in Swedish.

The inventory report by the Geological Survey of Sweden was performed as a general screening and assessment of different types of geological storage in Sweden. Special emphasis was put on presence of suitable deep saline aquifers.

The Swedish bedrock is dominated by crystalline rocks, which have low or no potential for storage of CO_2. A few large asteroid impact structures in the crystalline bedrock such as the Siljan structure occur where heavily fractured rocks at depths below 1000 m are capped by a zone with sealed fractures (cap rock). These structures are, however, based on existing data, judged to be less suited for CO_2 storage due to insufficient effective porosity and uncertain tightness of the cap rock.

Recent research postulates a great potential in the future for in situ mineralization of CO_2 in basaltic rocks such as the rocks on Iceland and the Columbia basalts in the USA. Although there are in Sweden areas with comparable suitable rocks,

most of these are also significant ore bearing formations and thus not considered suitable for CO_2 storage.

The report from the Geological Survey of Sweden states that there remain only two or possibly three alternatives for geological storage of CO_2 in Sweden. These are located within sedimentary bedrock basins in southwest Scania, in the south Baltic and in the southern Kattegat. In these areas, there are deep sandstone aquifers with sufficient porosity, permeability, thickness and distribution. The identified sandstone layers are also here covered by potentially tight cap rocks. There are, however, no closed traps (anticlines, domes, etc.) large enough, which could primarily be utilized for storage. Storage in the regionally distributed horizontal and sub-horizontal sandstone layers could, therefore, only be envisaged if it is proven that the stored CO_2 will have a localized distribution and not migrate beyond accepted boundaries.

Of the three areas above, the Cambrian sandstone in the south Baltic is considered the most suitable candidate for CO_2 storage. The sandstone formation is extending into Lithuania, Latvia, Russia (Kaliningrad enclave) and Poland. Here findings of hydrocarbons prove an existing reservoir and tight cap rocks. Assessment of storage capacity has not been performed to any greater accuracy due to lacking data on the reservoir dynamics. Preliminary estimates give storage capacities ranging from a few 100 Mt to several Gt CO_2 depending on the storage factor and the hydraulic situation. A national research and pre-investigation programme has been proposed by the industry as well as the university community with the aim to improve the accuracy in evaluation of the storage potential in the south Baltic. This work has not yet started.

The sandstone aquifers in southern Kattegat are considered less suitable, due to their low storage volume (<100 Mt).

8-D Public Acceptance

To date, relatively little is known about public perceptions of CCS in Sweden. Studies so far indicate that, just like most other countries, only a minority of the Swedish population has heard about CCS. A survey conducted in Sweden as early as 2004 found that about 15 % of the respondents claimed to have heard about CCS[18]. To make a rough comparison, a Special Eurobarometer on CCS from 2011 showed that on average 10 % of the respondents in 12 surveyed countries had

[18] The Alliance for Global Sustainability (2007) Public and stakeholder attitudes towards energy, environment and CCS, AGS Pathways report 2007:E2, http://www.energy-pathways.org/pdf/R4_public_and_stakeholder_attitudes_towards_energy.pdf

heard of CCS[19], although it varied substantially between countries. Sweden was not included in the Eurobarometer survey.

Several researchers have stressed cautiousness in interpreting surveys on people's awareness and attitudes towards a technology they barely know. Attitudes are highly sensitive to the methodology used[20]. The 2004 survey showed that Swedish respondents were predominately unsure of their support for CCS, which seems reasonable given the small fraction of people that agreed they had heard of CCS.

Swedish companies, however, have been active in advancing the technology, most notably state-owned Vattenfall. A great deal of the Swedish media attention on CCS has concerned Vattenfall's CCS-activities in Germany[21]. No large-scale public protests against the technology in Sweden have been recorded, although the general debate reveals both proponents and opponents.

Finally, one can note some differences in Swedish industry stakeholder positions on CCS. Several energy-intensive base industries have stated that CCS will be important for their further efforts to limit their CO_2 emissions. However, the forest sector, which represents a relatively large share of the Swedish biogenic CO_2 emissions, has not been particularly keen on the technology, arguing that biogenic emissions should be perceived differently. Moreover, the political debate on CCS in Sweden has been limited so far.

[19] European Commission (2011) Special Eurobarometer 364, Public Awareness and Acceptance of CO_2 capture and storage, http://ec.europa.eu/public_opinion/archives/ebs/ebs_364_en.pdf
[20] Malone E., Bradbury J., Dooley J. (2009) Keeping CCS Stakeholder involvement in perspective, Energy Procedia, 1 (1, 2009) : 4789-4794
[21] Buhr, K. and Hansson A. (2011) Capturing the stories of corporations: A comparison of media debates on carbon capture and storage in Norway and Sweden, Global Environmental Change: Human and Policy Dimensions, 21, 336-345

9. Electricity

9-A Policies overview including major changes since previous IDR

The Swedish government has opened up for replacement of old nuclear power plants at the same locations as the present ones. However, there will be no state subsidies to support any such replacement. The government's policy is also to increase the renewable energy production to reduce the dependence on the two predominant production sources of today (hydro and nuclear) and the fulfilment of national environmental objectives.

In the summer of 2011 the Government presented several suggestions on how to strengthen the consumer's role in the electricity market. Among other things it is suggested that consumers should be able to have their electricity consumption measured hourly if they want to. The consumer should also be able to give third parties access to their meter values. Furthermore there are several measures suggested to increase the amount of micro production.

Sweden has been divided into four separate bidding areas as of 1 November 2011. This will from time to time result in differing prices for electricity within Sweden. Any price differences will send investment signals to the market on where new power plants are needed and where the transmission capacity should be increased.

As of 1 January 2012 Norway has joined the Swedish market for green certificates, resulting in a joint market.

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9-B Previous IDR recommendations

The government of Sweden should:

- *Continue to harmonise and improve the Nordic wholesale electricity market, focusing particularly on transmission grid investment and congestion management; consider increased co-operation with neighbouring markets, preferably through market coupling.*

Developments regarding Swedish efforts to improve the Nordic wholesale electricity market and cooperation with neighbouring markets have taken place since 2008.

Sweden has participated actively in the efforts by the Nordic Council of Ministers to further a common Nordic electricity market. This participation has been through the Minister of Energy as well as through participation by the ministry in the Electricity Market Group (EMG), which prepares the minister meetings. Furthermore, the EMG has been working through two channels, one is direct invitations to the NRA, the TSO and sometimes industry organisations to investigate possible improvements in different aspects of the market and the other is to directly engage consultants to propose mew solutions to difficult problems. The Nordic Council of Ministers has made declarations of priorities for the Nordic electricity market. In general, there has been a dialogue often spanning several years where options have been evaluated from different points of view. Thus, important work has been done regarding congestion management and investment in transmission in order to reduce congestions in the Nordic market. The Nordic TSOs through Nordel have been forerunners in common Nordic plans for investments in transmission grids, based on common Nordic cost benefit analysis. However, investments have been slower than expected, and Nordic NRAs were invited to support this common grid planning through an investigation into the regulatory barriers to investment for common Nordic investments. The findings are in line with findings on the European level – permitting process including resistance against overland transmission lines, cost sharing issues, criteria for investments to be deemed beneficial. During the later years the investment budgets of the Nordic TSOs have increased dramatically, and important investments are in the pipeline. In Sweden the Energy Markets Inspectorate has recommended the Government to approve the application for permission for the South West Link, which will considerably reduce congestion.

Furthermore, The Swedish TSO is engaged in the NordBALT HVDC link which will be built between Sweden and Lithuania, linking the Baltic market closer to the Nordic market.

The two HVDC links between Sweden and Germany and Poland, respectively, have been market coupled: Baltic Cable from 2 May 2010 and SwePol Link from 15 December 2010.

As of November 2011, Sweden is divided into four bidding areas as part of the agreement with the European Commission (DG COMP). This has led to a situation where reduction of interconnector capacity with neighbouring countries can be limited to a minimum. Svenska Kraftnät sends quarterly monitoring reports to the European Commission; the reports are available on the website of Svenska Kraftnät, www.svk.se.

In addition to the above, there has been a continuous work aiming at further harmonisation of rules related to operations and related to the common balancing

(Nordic regulation power market in place since 2000). The Nordic regulators cooperate actively in the common organisation NordREG. Furthermore, Nordic regulators are active in the cooperation related to single price coupling and intraday market in the so called NWE region (Nordic, Germany, Poland, Netherlands, Belgium, Luxembourg, France and UK).

Furthermore Nordic regulators are active in the creation of new legal structure for the internal electricity market in the form of Framework Guidelines and giving an opinion on the draft Network Codes according to the process set forth through the Third Package.

- *Continue efforts to establish a Nordic retail electricity market.*

The organisation of the Nordic Energy Regulators (NordREG) has intensified its efforts to harmonise the Nordic electricity retail markets.

There is strong political backing from the Nordic governments to achieve the goal of a common Nordic retail market. The aim is to have reached a level of harmonisation by 2015 that the main benefits of the harmonisation will be realised.

The work of achieving a common market has been intensified during the last couple of years. Starting in 2010 a project organisation with four task forces and a steering group was set up. Funding for a full time project coordinator and consultants has been granted by the Nordic Council of Ministers (3 million DKK in 2011 and 1, 5 million DKK in 2012). The main parts of the analyses are made by NordREG but there is close cooperation with relevant stakeholders and experts throughout the process.

The aim for each task force is to analyse and recommend how the regulatory framework could be harmonised in order to lower the barriers between the countries so that it is easy and inexpensive for suppliers to establish their business across the Nordic borders.

At the same time as NordREG is working to harmonise the regulatory framework, efforts are also being made to increase competition and to make the retail market more customer friendly. This is also the reason for recommending a revised market model for the future Nordic retail market. The present dual point of contact market model, where the customers very often need to contact both the distribution system operator (DSO) as well as the electricity supplier is suggested to be changed to a supplier centric market model with mandatory combined billing.

In addition to NordREGs work there is also an on-going project by the Nordic TSOs to establish a common Nordic balance settlement unit. The aim is to have

this common unit in place in time to support the common Nordic retail market by 2015.

- *Increase efforts to promote competition both in Sweden and in the Nordic area by, among others, lowering barriers for new entrants and considering the positive implications of reducing joint- and cross-ownership of power plants.*

The Swedish nuclear power plants are all jointly owned. To reduce the risk of co-operation between the owners and other negative effects of the joint ownership an independent surveillance group was set up by the Swedish government in 2010 to follow the power plants work. The assignment of the group is to attend the power plants board meetings to ensure that there are no undue discussions that might jeopardize market competition.

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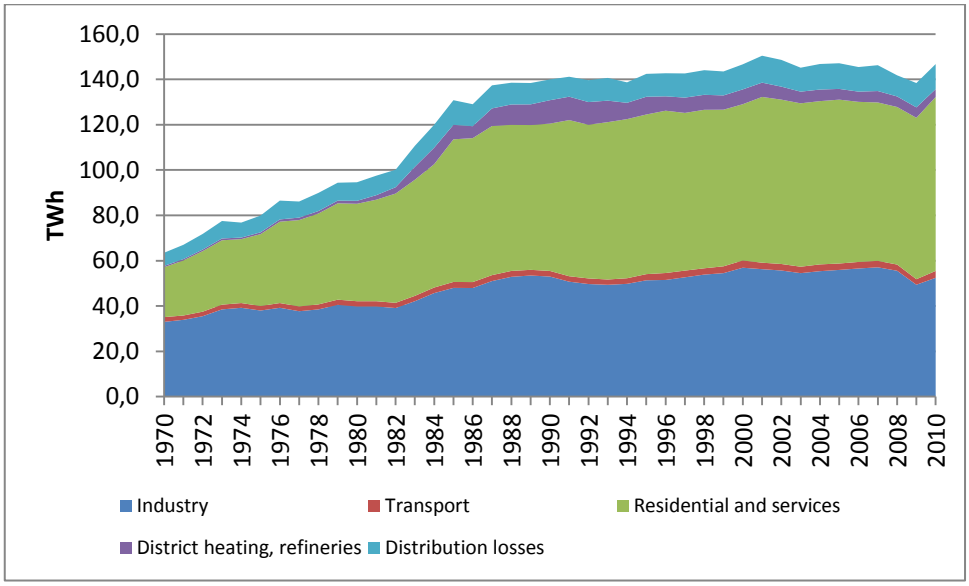
9-C Demand

Between 1970 and 1987, electricity use in Sweden rose on average almost 5 % per year. Since then, the electricity consumption in Sweden has, as seen in figure 9, been relatively stable over the last years. Economic and technological development, development of energy prices, business structures, population changes and outdoor temperatures are all factors that affect electricity use.

Figure 6: Use of electricity in Sweden by sector, 1970–2010, in TWh



The total electricity use, including distribution losses, 2010, amounted to almost 147 TWh. This represents an increase compared with 2009 when the total electricity use reached 138 TWh. This increase is due to the improved economic conditions.

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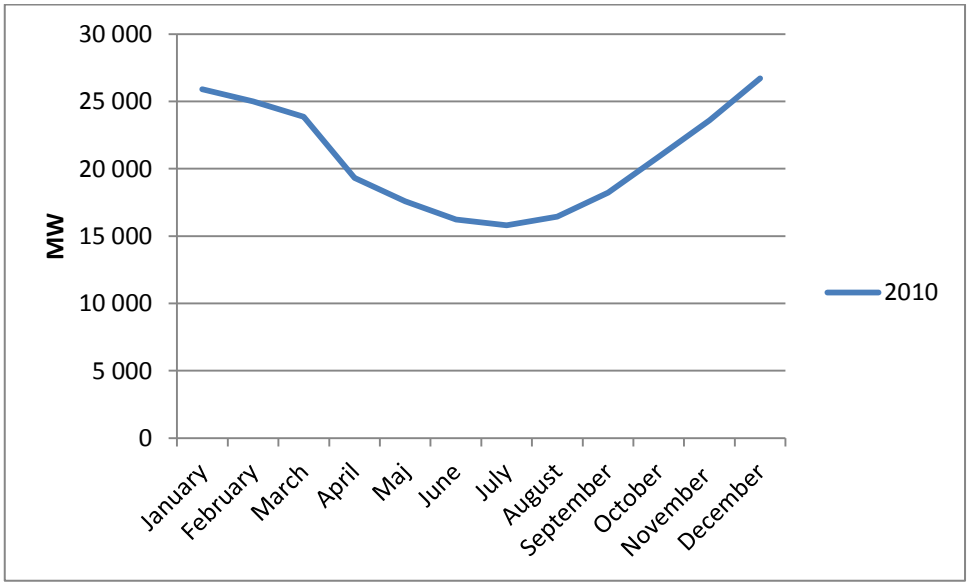
9-D Peak demand and seasonality

Swedish electricity consumption is highly influenced by a large share of energy intensive industries as well as a large share of electricity heated houses. The high share of electricity heated houses, in combination with relatively cold winters, makes the consumption vary significantly between summer and winter.

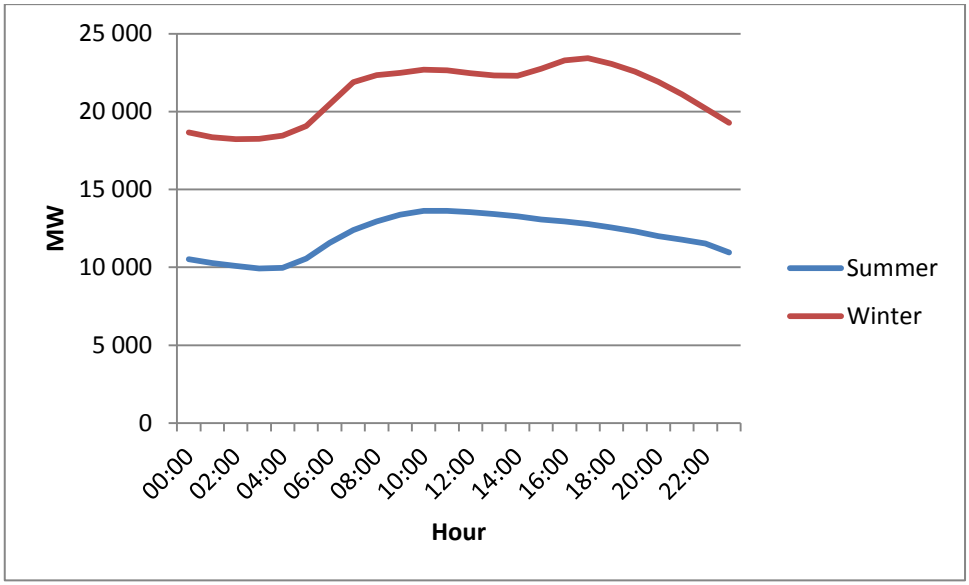
Peak load usually occurs during periods of cold spells. In 2010, the maximum load in Sweden occurred at 22 December, hour 17-18 (26 700 MW).

Figure 7: Peak load, MW, per month



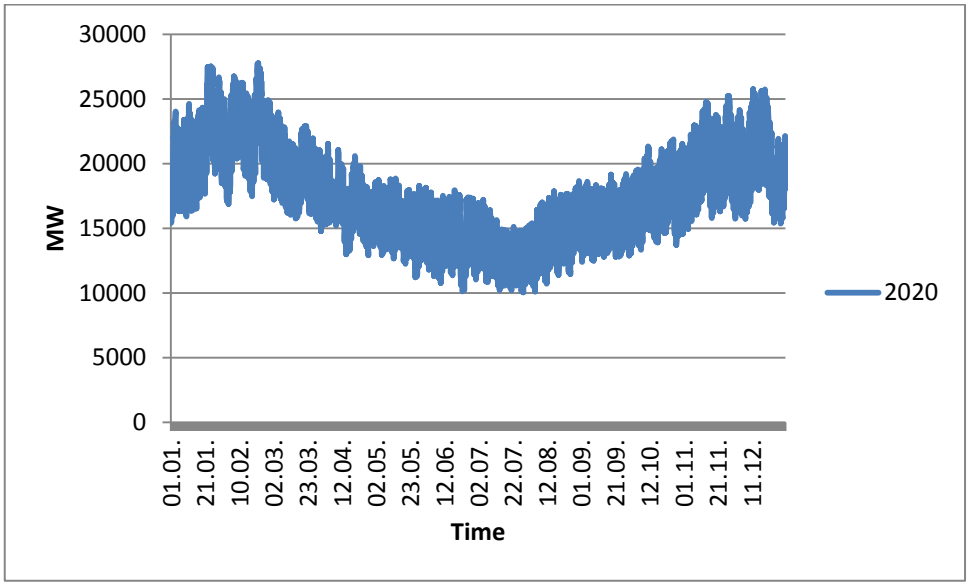
Sweden has the highest note at 27 000 MW, which occurred on 5 February 2001.

Figure 8: Peak load, 2010 MW, day, summer & winter



Peak load located at 27, 2 GW -27, 7 GW, year 2020.

Figure 9: Peak load, 2020 M



Peak load located at 27, 2 GW -27, 7 GW year 2020.

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9-E Demand side policies

As for now there are no interruptible contracts, real-time pricing or time-of-use pricing contracts offered to customers in Sweden. However, customers with fuse larger than 63 amperes have their consumption read hourly. For customers with fuse less than 63 amperes the Swedish government has presented a proposal to the parliament in April 2012 which if adopted will give consumers a possibility to require hourly reading without additional metering costs from 1 October 2012.

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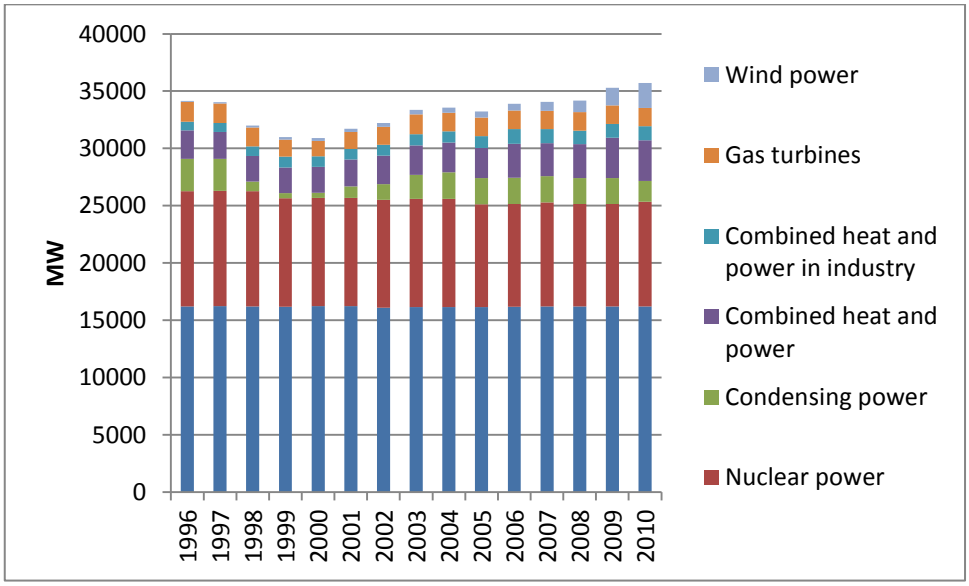
Reference hourly metering: http://www.regeringen.se/sb/d/15856/a/186517

9-F Existing and New Capacity

During the second half of the 1990s, the installed production capacity of Swedish power plants dropped significantly. After 2000, this capacity increased once more and has passed the level from before deregulation. New capacity includes wind power and biomass power through the electricity certificate system and the increased capacity of nuclear power plants.

Figure 10: Installed electricity production capacity in Sweden, 1996–2010, in MW



The aggregate installed capacity in the country's power stations at the end of the 2010 was 35,701 MW divided between the various types listed in figure 13, or by fuel type according table 15.

The total installed capacity consists of 45% hydropower, 6% wind power, 26% nuclear power and 23% other thermal power. Table 16, showing installed capacity by fuel type, is somewhat misleading since the primary fuel is denoted for the

entire capacity while in reality many plants use several different fuels simultaneously.

Table 16: Installed capacity in Swedish power plants, MW

	31 Dec. 2009	31 Dec. 2010
Hydropower	**16 203**	**16 200**
Wind power	**1 560**	**2 163**
Nuclear power	**9 342**	**9 151**
Other thermal power	**8 608**	**8 187**
- CHP, industrial	1 199	1 216
- CHP, district heating	3 531	3 563
- Condensing power	2 271	1 801
- Gas turbines, etc.	1 607	1 607
Total	**35 713**	**35 701**

Table 17: Installed capacity in Swedish power plants by fuel type, MW

	31 Dec. 2009	31 Dec. 2010
Nuclear power	**9 342**	**9 150**
Fossil power	**5 502**	**5 035**
Renewable power	**20 869**	**21 516**
- hydropower	16 203	16 200
- waste	282	293
- biomass	2 824	2 860
- windpower	1 560	2 163
Total	**35 713**	**35 701**

In total, the Swedish state owns approximately 40% of the country's power generation capacity, non-Swedish owners around 40%, municipalities around 12% and others roughly 8%.

Table 18: Four largest company assets in Sweden, MW, 1 January 2011

Company	Hydro power	Nuclear power	Wind power	Other thermal power	Total
Vattenfall AB	7 941	4 682	261	668	13 552
E.ON Sverige AB	1 788	2 668	18	2 078	6 552
Fortum Power and Heat AB	3 135	1 690	0	994	5 819
Statkraft Sverige AB	1 261	0	0	0	1 262

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9-G Import and export

In 2010, net imports to Sweden amounted to 2,1 TWh of electricity, compared with net imports of 4.7 TWh the year before. Trade flows between Sweden and its neighbouring countries vary both from year to year and during any given year. Exchange between countries is governed by price differences between different price areas. In 2010, net imports of electricity to Sweden came mainly from Finland.

Figure 11: Electricity net import (+) and net export (–) in Sweden, 1970-2010, in TWh

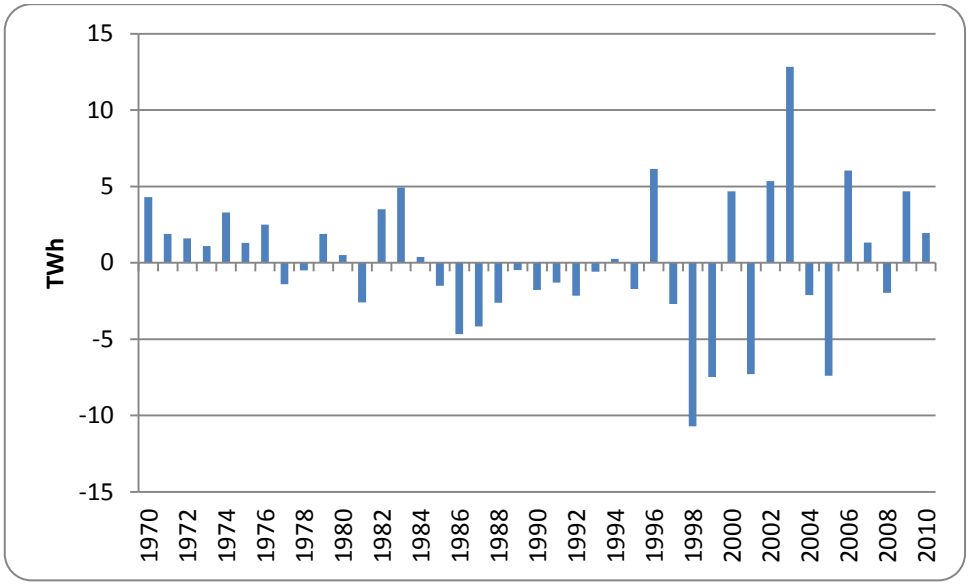

Table 19: Annual values for Swedish electricity exchange with different countries in 2010, TWh

	To Sweden	**From Sweden**
Denmark	5,0 (3,1)	2,8 (3,8)
Finland	5,7 (4,1)	3,0 (2,9)
Norway	4,2 (7,8)	8,0 (2,6)
Poland	2,3 (1,1)	1,0 (0,9)
Germany	2,3 (1,1)	1,0 (0,9)
Total	**17,7 (16,4)**	**15,6 (11,7)**

(Data for 2009 in brackets)

Projects

NordBalt

NordBalt is a project for the construction of an electricity interconnection (300kV, 700 MW) between Klaipėda in Lithuania and Nybro in Sweden, implemented by transmission system operators Svenska Kraftnät and Litgrid (Lithuania). The aim of the project is to promote trade in electricity between the Baltic and Nordic electricity markets and increase the security of electricity supply in both regions. The entire project is valued at EUR 552 million. The European Union has

approved the financial support of EUR 175 million to this project. The majority part of these funds – EUR 131 million - will be used for the construction of the link, and the rest for the reinforcement of Latvian electricity transmission system. The interconnection is planned to be in operation by the end of 2015.

Fenno-Skan 2

Fenno-Skan 2 is a strengthening of the existing DC link between Sweden and Finland. The new link will be built between Finnböle in Sweden and Rauma in Finland. The project is run by Svenska Kraftnät and the Finnish Fingrid Oyj. Fenno-Skan 2 was first in operation by the end of December 2011. The new link will increase the transfer capacity between the countries by around 40 percent and thereby increases the opportunity to trade electricity on the Nordic electricity market. The link will also reduce transmission losses in the Nordic electricity network and increase operational reliability. The total cost for the whole project is EUR 300 million, of which the Swedish share is around SEK 1.7 million. The link consists of around 200 km undersea cable and around 100 km overhead line. Its capacity will be 800 MW.

The South West Link

The South West Link is Svenska Kraftnät's largest and single most important network investment. Its aim is to reinforce the AC network, increase operational reliability and deal with limitations in transmission capacity to southern Sweden and between Norway and Sweden. The South West link is an important part in the necessary development of the national grid, required to enable the production of renewable energy as planned in accordance with Sweden's and the EU's energy policy objectives. The South West link also contributes to limiting the differences in electricity prices that can occur between different electricity areas in Sweden. The South West Link consists partly of a new AC link between Barkeryd and Hallsberg, and partly of a DC link between Norway and Skåne with a nodal point in Barkeryd. The north and south branches are estimated to be completed at the end of 2014 or beginning of 2015. The west branch is estimated to be ready at the earliest by 2018. The three branches of the South West link will in total be 700 – 800 km.

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9-H Industry structure

In 2010, the three largest electricity generators, Vattenfall, Fortum and E.ON Sverige together accounted for 80 % of Sweden's electricity generation. Vattenfall, which is 100 % owned by the Swedish state, alone accounted for 42 %

of the electricity generated in Sweden whilst E.ON Sverige and Fortum (100% owned by the Finnish state) generated 19 % respectively 18 % of the Swedish electricity during 2010.

The Swedish wholesale market is a part of a common Nordic market. In the Nordic electricity market, electricity is traded on the Nordic electricity exchange, Nord Pool. The market share of the four largest electricity generators in the Nordic region was 50 per cent in 2010. Vattenfall accounts for 18 % of the electricity generated in the Nordic market. As the Nordic area is divided into different bidding areas and potentially several different price areas (depending on bottlenecks in the transmission grids) the actual market share for the four largest electricity generators can differ hour to hour in relation to the conforming price areas.

In 2010, the three largest electricity retailers had a market share of more than 50 %. Vattenfall El (22%), E.ON Försäljning (19%) and Fortum markets (12%). In total there are 120 retailers in Sweden.

The transmission grid is operated by the state owned company Svenska kraftnät which is the TSO. The company has no relationship with any other electricity companies.

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9-I Map

Reference:
http://www.svk.se/pagefiles/29438/svk%20annual%20report%202010_single%2033.pdf

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9-J Transmission, infrastructure and access

Transmission tariff

Svenska Kraftnät uses a point of connection tariff system for the national grid. The overall objective of the transmission tariff is to cover costs for operation and maintenance as well as provide correct signals to the market in order to promote an efficient use and development of the grid.

The conditions for utilization of the transmission grid are regulated in the use of the grid contract. According to the contract, the grid user shall pay a fee to

Svenska Kraftnät for the utilization of the grid. Svenska Kraftnät has over 140 connection points to the grid and approximately 25 grid customers consisting of owners of large electricity generator facilities and regional grids.

Tariff structure

The tariff structure is based on a point of connection tariff system. The users of the grid are charged for injection or outtake of electricity at a connection point in the transmission grid. The tariff level is not dependant on the distance between generation, or source of energy, and load. Generation from renewable energy sources pay the same fees as conventional power plants. The transmission tariff consists of two parts, a power charge and an energy charge. These are described under each subheading below.

The power charge

The power charge covers costs for expansion, operation and maintenance of the transmission grid. It is based on annual capacity subscription for injection and outtake of electricity at each connection point. The cost the subscriber has to pay is the product of the annual capacity subscription and the power charge in the connection point.

The power charge is geographically differentiated, in that the fees for injection of power to the grid are lowest in the south and then increase linearly with the latitude to reach their highest values in the north. The reverse applies for outtake of power. In 2011, the power charge is 10 SEK/kW in south and 48 SEK/kW in the north for injection of power on the grid. For taking power from the grid the charge is 87 SEK/kW in the south and 17 SEK/kW in the north. Generators pay approximately 30 % and consumers pay approximately 70 % of the total tariff charges. The geographically differentiated power charge provides a long-term locational signal on where it is optimal to add generation and load capacity from a grid perspective. There is a surplus of generation capacity in the north and this surplus needs to be transferred to the load centre in the south. From a grid perspective, it is favourable to add generation capacity in the south and consumption in the north in order to reduce losses and the need for transmission expansion.

If the grid user temporarily wants to exceed his annual capacity subscription, he can apply for a temporary capacity subscription for either one or four weeks. The application for a temporary capacity subscription will be approved by Svenska Kraftnät if there is enough capacity on the grid. The charge for temporary capacity subscriptions is based on the annual capacity charge and is more costly compared

to the ordinary capacity subscription. The charge for a one week temporary capacity subscription is 1/12 of the annual capacity subscription, and for a month 3/12 of the annual capacity subscription. If the grid user exceeds the capacity subscription three hours in a row, the user is charged 1/50 of the annual fee per hour from the third hour. The subscriber is exempted from the penalty charge if the excess capacity is caused by the real-time sale of regulation power, a failure or maintenance on the transmission grid.

The energy charge

The energy charge is based on the transmission losses in the transmission grid caused by injection and outtake of electricity in different connection points. It is dependent on how the generation or load is distributed in the grid and consists of three different components:

- Loss coefficient
- Correction coefficient
- Electricity price for procured losses

In 2011, the energy charge varied between (-) 22, 8 to 30, 8 SEK/MWh depending on connection point. For each connection in the grid, a loss coefficient is calculated corresponding to the change of energy losses when an additional unit of energy is injected or taken out from the grid. The loss coefficient is symmetrical for generation and load in a connection point. When the coefficient is positive the user is debited when injecting power and credited when taking power from the grid. A negative coefficient implies the opposite.

The correction coefficient is a scale factor that converts the loss coefficients into average losses. The reason for using average losses is to avoid overcharging or overcompensation of grid users.

The electricity price for procured losses is based on the price Svenska Kraftnät pays for procuring power to compensate for the losses on the transmission grid. The price is set in advance for one calendar year at a time. From 2012, the losses will be procured directly on Nord Pool Spot and hedged by procuring financial contracts.

The energy charge in a connection point, which is calculated as the product of the three components above, is multiplied by the grid users' energy injection or outtake. Depending on whether energy exchange reduces or increases the losses the user will be debited or credited the amount corresponding to the energy charge multiplied by energy injection or outtake.

In 2010, the total amount of energy taken from the system was 108 TWh and the losses were 2, 4 TWh. The size of the losses is dependent not only on the amount

of power transferred on the grid, but also on hydrology and where the power is generated and consumed. During a year with a hydrological surplus, the hydro power in the north injects more energy on the grid compared to a year with normal hydrology and the losses increase since the power needs to be transferred long distances.

Annual process

The tariff level is reviewed by Svenska Kraftnät on an annual basis and set in August for the coming year. The grid users are informed about all important amendments of the tariff in advance and all changes are discussed in the Electricity market council, which is Svenska Kraftnät´s information and consultation forum for the market actors.

The current charges can be found in the price list, which is an appendix to the use of the grid contract. The price list for the coming year should be available for the grid users at the latest in the middle in September the year before.

Network losses and outages

The losses in the Swedish transmission system was 2, 4 TWh in 2010 (2, 2 % of the energy extracted from the transmission system) and 2, 7 TWh in 2009 (2,6 %).

Energy not supplied was 5 MWh in 2010 and 5 MWh in 2009.

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9-K Cross-border transmission lines

Existing interconnections:

- Sweden (SE1) – Finland: two 400 kV AC lines; 1500 MW export, 1100 MW import
- Sweden (SE3) – Finland: two HVDC links (400 kV DC and 500 KV DC); 1350 MW export and import
- Sweden(SE1) –Norway: 400 kV AC; 600 MW export , 700 MW import
- Sweden (SE2)-Norway: 220 kV AC; 300 MW export, 250 MW import
- Sweden (SE2)-Norway: 400 kV AC; 1000 MW export, 600 MW import
- Sweden (SE3)-Norway: Two 400 kV AC; 2095 MW export, 2145 MW import

- Sweden (SE4)-Denmark: Two HVDC links (both 285 kV DC); 680 MW export, 740 MW import
- Sweden (SE4)-Denmark: Two 400 kV AC-cables (and two 135 kV cables not part of the transmission system but of importance to trading capacity); 1300 MW export, 1700 MW import
- Sweden (SE4) – Germany: HVDC link (450 kV DC); 610 MW export and 600 MW import
- Sweden (SE4) – Poland: HVDC link (450 kV DC); 600 MW export and 618 MW import

Planned interconnections:

- Sweden (SE4) – Lithuania: VSC HVDC link (+/- 300 kV DC); 700 MW
- Sweden (SE3) – Norway: Two parallel VSC HVDC links in a multiterminal configuration with internal VSC HVDC links in Sweden (+/- 300 kV DC); Technical capacity 1400 MW, NTC will be lower and calculated as part of existing connection Sweden (SE3) – Norway)

Procedure to allocate interconnection capacity among market participants

All capacity for interconnectors within the Nordic area (i.e. between Sweden, Norway, Finland and Denmark) are handled with implicit auction

Baltic cable (Sweden-Germany): The capacity of the cable is included in the Market Coupling (implicit allocation) between Germany and the Nordic markets.

SwePol Link (Sweden- Poland: Day ahead implicit allocation only.

Transmission congestion management methodology for domestic transmission networks and interconnections

Since 1 november 2011 Sweden is divided into 4 biding areas. As such the congestion management within Sweden is handled by market splitting.

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9-L Distribution infrastructure and access

There are approximately 170 distribution network companies in Sweden, and more than five million customers are connected to the electricity network. The largest network companies – Vattenfall Eldistribution (owned by the Swedish state), Fortum Distribution and E.ON Elnät Sverige – each have more than 800 000 customers. The smallest network companies have less than 1 000 customers. The companies are a mix of cooperative economic associations, privately owned companies and municipalities. It is common that production, distribution and trade are carried out within the same corporate group.

The electricity act states that everyone has the right to be connected to the grid. The DSO: s set their own prices for connection. The customer can complain to the regulator about the level of the connection fee, the regulator then tries the fairness of the level of the fee. The DSO set their own tariffs which are tried by the regulator (ex. ante. from 2012)

Losses in the distribution network 4,3 TWh. Average outages 93 minutes in 2010.

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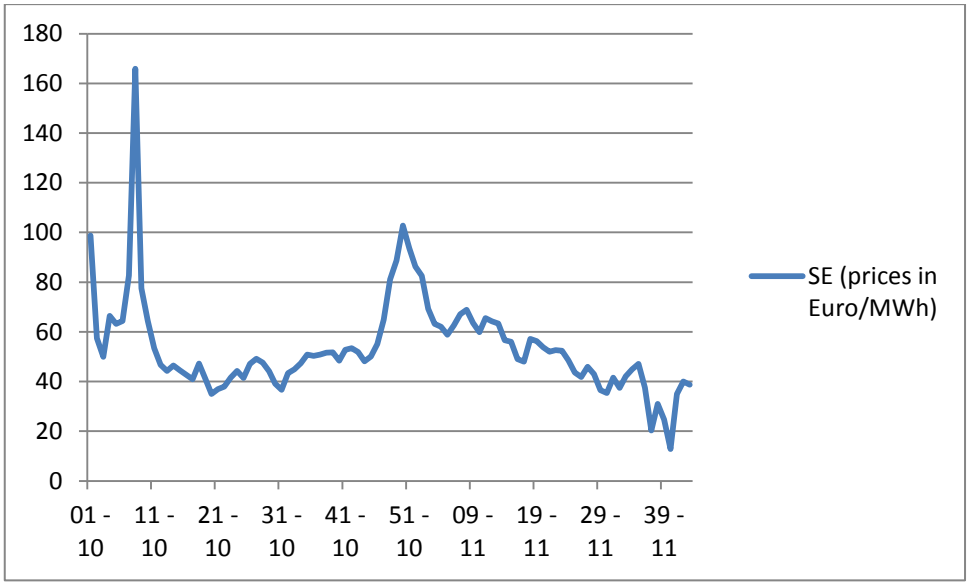
9-M Market Overview

The Swedish market is open for competition to all customers. This has been the case since the market reform in 1996.

The governments in the Nordic countries are actively working to create a common Nordic retail market for electricity. The ministers for energy Nordic regulators have set a goal of creating such a harmonised Nordic retail market by 2015.

Figure 12



The Swedish wholesale market is a part of a common Nordic market. In the Nordic electricity market, electricity is traded on the Nordic electricity exchange, Nord Pool.

Since Sweden is located in the centre of the Nordic region, the country is to some extent a transit country. During rainy years, cheap hydropower flows southwards from Norway through Sweden to the continent. During dry years expensive thermal power flows northwards.

The number of electricity suppliers in Sweden has fallen since the electricity market was reformed. In 1996, there were over 220 suppliers in Sweden. By 2011, this figure had fallen to 120. All of these companies sell electricity to end users and around 40 companies operate throughout the country. The decline in the number of electricity suppliers is mainly due to acquisitions and mergers. In 2006, the three largest electricity retailers – Vattenfall El, E.ON Försäljning and Fortum Markets – had a market share of approximately 50 per cent. In 1996, when the market was deregulated, the three largest companies had a market share of just over thirty per cent.

During 2010 more than 1, 5 million domestic customers, or 34 per cent, were active on the Swedish electricity market, either by renegotiating their contract or by switching electricity supplier. Approximately 11 per cent of the Swedish domestic customers switched suppliers during the year. Since the electricity market was reformed in 1996, around 78 per cent of the households have switched supplier or renegotiated their contract. Customers living in houses are generally more active than those living in apartments.

There are measures being taken to increase the competition and the consumer activity in the market. Within the work to create a common Nordic retail market there are plans to change the market model and the customer interface from the present dual point of contact model, where consumer in many cases need to contact both the DSO and the supplier, to a more customer and market oriented supplier centric market model. It is expected that this change will increase the connection between the customer and the supplier and reduce the connection between the DSO and the customer. It is likely that this will make the market more attractive for new suppliers to enter the (bigger) common Nordic market at the same time as the change reduces the benefits that integrated suppliers can draw from their close connection to the local DSO. These changes should be in place by 2015.

Currently customers with fuse larger then 63 amperes have their consumption read hourly. For customers with fuse less then 63 amperes the Swedish government has proposed hourly reading of household customers to be voluntary as from 1 October 2012. The measure is expected to increase the customers' possibility to adapt their consumption to peak and off peak hours.

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9-N Regulatory institutions

The Energy Markets Inspectorate is the regulatory authority. The Inspectorate is an independent authority. The Inspectorate is responsible for regulating network tariffs for transmission and distribution of electricity and natural gas.

The Swedish Competition Authority is responsible for ensuring fair competition and that no market actor is abusing a dominant position in the market.

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9-O Distributed and variable renewable power integration

The level of bio fuel-fired CHP-plants and wind power units is constantly increasing. 2011 wind power generation accounted for 6,1 TWh (4,2 % of Swedish power generation) which is an increase from 3,5 TWh in 2010 and 1,4 TWh in 2007.

Renewable electricity production is covered, and supported, by the electricity certificate scheme, see section 4-E.

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9-P Smart Grid

On the basis of a report on smart grids by the Swedish Energy Markets Inspectorate the Swedish government made some statements in the bill 2010/11:153 about empowering consumers in the electricity market. Sweden should take advantage from the development of Smart grids. Smart grids will facilitate the achievement of ambitious national energy- and climate targets and empower electricity consumers. Smart grids are also an opportunity for growth since the global market for smart grid solutions is expected to grow substantially. In some ways Sweden is leading the development. One example is that "smart meters" are already installed in around 90 per cent of Swedish households. Another example is that Sweden (Uppsala University with Royal Institute of Technology) was chosen to lead EU innovation on smart grids within KIC InnoEnergy, see below. The power technology industry is also well developed in Sweden with ABB as the most well known company.

The government has decided to establish a national smart grid council and a knowledge platform (10 MSEK per year 2012-2014) which should also develop a national action plan.

References:
http://ei.se/Documents/Publikationer/Rapporter%20och%20PM/Rapporter%202011/Adapting_electricity_networks_to_a_sustainable_energy_system_EIR_2011_03.pdf

http://www.regeringen.se/sb/d/14220/a/172314

To promote implementation of Smart Grid technologies in Sweden, there are a number of actions taken. Example of on-going research programmes and demonstration projects are presented below as well as information regarding the previously Swedish rollout of AMR/AMM systems.

Smart Grid Research Programmes

In Sweden there are several research programmes that address smart grid issues. The Swedish Energy Agency partly finance the below mentioned programmes.

SweGRIDS

The programme includes basic research in the areas of Smart grids, information and communication technologies (ICT), energy storage and material and is closely

linked to the KIC InnoEnergy22. The main purpose of the centre is to develop scientific knowledge and technology as the Swedish and European electricity network requires, in particular within the following areas: integration of all forms of renewable electricity generation, managing a greater degree of varying power flows and use of real-time information. Implementers of projects are PhD students or post doctorates registered at KTH and Uppsala University.

Research projects are designed to directly fit the InnoEnergy five thematic areas:

- SMART POWER: Smart power systems from producer to consumer
- INSTINCT: ICT tools for smart electricity grids
- CIPOWER: Steerable and intelligent power components
- STORAGE: Electrical Energy Storage
- MATERIAL: Materials for smart electricity grids

http://www.kic-innoenergy.com/co-locations/cc-sweden.html

Elektra

The aim of the research programme Elektra is to strengthen the Swedish industry's competitiveness, primarily in the sectors of: electricity suppliers, power industry and manufacturing industry in the long-term perspective. This is achieved by collaborative research between universities and industry through mainly postgraduate education.

The programme covers both traditional power technical issues such as electric power materials and electric motor loads as well as the application of new knowledge from other areas, such as information technology, automatic control, and signal theory. The collaboration between the universities and the electrical power engineering industry creates innovation and scientific knowledge, which is exploited by the industry for the development of new products and services, which may lead to commercially useful results and contributes to maintaining the competitiveness of the industry.

The research activities within Elektra are organised in four research areas:

- Electromagnetic systems

[22] The goal for InnoEnergy is to pave the way for a sustainable energy system enabling a climate-neutral Europe by 2050 to be achieved by successful commercialization of innovations. The Swedish co-location centre (CC) within InnoEnergy is responsible for coordination of Smart Electricity Grid and Storage throughout the consortium.

- Power electronic systems
- Electric power systems
- Power electric components

EKC2

The research activities within the Swedish Centre of Excellence in Electrical Power Engineering, EKC2, is organised in four research programmes:

- *Maintenance Management*, focusing on strategies for, and planning of power system maintenance, including aspects such as reliability centered maintenance and component life-time modelling and diagnostics, as well as support tools such as information systems.
- *Controllable Power System*s, focusing on economic as well as technical control of power systems in deregulated power markets.
- *IT applications to Power system operation and control*, focusing on non-functional aspects, such as performance, reliability and security, of using information systems for communication and automation of power grids.
- *High Performance Electrical Machines Drives*, focusing on design and development of electrical machines and drives that can achieve high performance for a large set of applications

Smart Grid RD&D projects

To enhance the development of Smart Grid technology, several RD&D projects are planned in Sweden, and among key activities in the smart grid roll out in Sweden are three pioneering projects; Smart Grid Hyllie, Stockholm Royal Seaport and Smart Grid Gotland. All projects are cutting edge in the smart grid field and all are aiming to become international role models for sustainable power systems. The Swedish Energy Agency partly finances the Smart Grid Hyllie demonstration project and has previously financed the pre-studies for the Stockholm Royal Seaport project and the Smart Grid Gotland project.

Smart Grid Hyllie

Hyllie is Malmö's largest development area and include approximately 9000 residences and nearly as many jobs. Hyllie will be used as an international reference project for future sustainable solutions with the application of smart technologies and become a place where a number of technologies and solutions will be applied first. The consumer's role in the future energy system will central. In addition to the consumer's future role a focus will be on the synergies between

energy carriers, mainly between electricity and heat. The project will show the way to Malmö's future as a sustainable city based on recycling, self-sufficiency, energy conservation and the use of renewable energy.

The infrastructure within Hyllie will be erected from scratch; the energy system will become an integrated part of the overall energy system of Malmö or possibly even be integrated with the Swedish electricity grid which is in turn interconnected with the European Transmission Grid. The design of a sustainable energy supply will look beyond the boundaries of Hyllie and consider all types of energy needed at the consumer side, including:

- Industrial processes.
- Electricity supply to, and heating & cooling of buildings.
- Infrastructure services (water supply, lighting, etc.).
- Energy for mobility.

Smart Grid Gotland

Smart Grid Gotland includes planning, building and development of a large-scale smart grid by upgrading the existing grid on the island. Gotland has a grid with high proportion of renewable energy (primarily wind power), connecting rural and urban areas on the island. It has been connected to the mainland via an HVDC link since 1954.

The smart grid project will combine new advanced equipment with new methods to incorporate renewable energy into the distribution network and create a more flexible production and distribution system. New measurement technologies will enable the consumers to actively participate in the energy demand. Smart grid functions to be implemented and tested include use of existing advanced metering infrastructure, advanced grid automation, and energy storage technology. New market models and services will be developed to involve active customer participation and pave the way for new market players. Through this development of the future smart distribution grid, consumers and producers will be fully integrated in a demonstration project that is likely to become an international model for a long-term sustainable electricity power system.

http://www.smartgridgotland.se/

Stockholm Royal Seaport

Stockholm Royal Seaport is a large-scale smart grid project where a former brownfield industrial area of 236 hectares is being transformed into a state-of-the art waterfront area with a high-tech smart grid integrated into several parts of the environment. The implementation of the new urban district includes development

of 10,000 new apartments and 30,000 new work spaces. Smart Grid functions to be implemented and tested from 2012 and onwards includes for instance smart meters and advanced metering infrastructure, demand response, grid automation, distributed storage and integrations of small scale renewables. The demonstration project will increase knowledge of optimization, control, maintenance, market concepts and regulation of future smart grid in urban areas and the demonstration project will implement a smart grid supporting and demonstrating climate mitigation in city areas.

http://www.stockholmroyalseaport.com/

ISGAN – International Smart Grid Action Network

The Swedish government decided on 31 March 2011 that Sweden shall join the International Smart Grid Action Network Implementing Agreement ("ISGAN IA") within the International Energy Agency. The Swedish Energy Agency was entrusted to take the necessary measures for the Swedish connection to the programme and otherwise be responsible for coordinating the Swedish participation. In 2011, Sweden notified participation in IEA ISGAN IA. Furthermore, a national coordination platform has been initiated, where representatives of industry, academia, and government agencies gather around issues related to the ISGAN and smart grids. Sweden participates in all the existing annexes, namely:

- Annex 1: Global Smart Grid Inventory

  Collect and catalogue the existing Smart Grid experiences

- Annex 2: Smart Grid Case Studies

  Develop common case study template and methodological framework

- Annex 3: Benefit Cost Analyses and Toolkits

  Methods and tools for benefit-cost analyses

- Annex 4: Synthesis of Insights for Decision Makers

  Integrate and synthesise lesson learned from the ISGAN programme

Smart Meter Deployment

To stimulate a deployment of smart meters, the Swedish parliament decided in 2003 that all electricity meters should be monthly read by July 2009 at latest. This requirement resulted in a full scale installation of AMR/AMM systems for nearly all Swedish consumers (5.2 million). The total cost for the full roll out of

AMR/AMM systems is estimated at 1.5 billion EUR. The main goals of the reform were increased consumer awareness and activity by e.g. more accurate electricity bills, simplified supplier switching processes and better information to customers about their actual consumption.

National Smart Grid Knowledge Platform

In order to increase the knowledge of smart electricity networks among, stakeholders and society at large interaction between different actors in the development of smart electricity networks should be strengthened. Therefore a knowledge-based platform to unite and disseminating relevant knowledge on research, development and demonstration in the field of smart electricity networks to all stakeholders will be created in 2012.

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9-Q Pricing Policy

There is no price regulation of any kind for electricity supply. Grid tariffs are regulated by the Swedish energy regulator (the Energy Markets Inspectorate).

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9-R Electricity security – supply

Reserve capacity hold by TSO, is approximately 1400 MW reserve power to be used for security of supply. The reserve capacity also consists of 400 MW in consumption reduction. The reserve capacity is to be phased out gradually until 2020. From there on the market is supposed to handle security of supply by itself.

Grid reinforcement within Sweden; The South West Link is a transmission line to reinforce the grid in north- south direction to be finished 2016. There are also several other grid reinforcement projects to strengthen the grid within Sweden. For a full list see www.svk.se

New interconnectors are planned to Finland, Poland and Lithuania.

The government has adopted a policy to diversify electricity generation implying that more renewables are promoted to reduce the dependence of nuclear and hydro.

New legislation concerning compensation for interruptions is forcing DSO: s to increase their security of supply by replacing overhead lines by ground cables.

For efficiency improvement the Swedish Energy Agency has a programme for energy intensive industries (Programme for energy efficiency, PFE).

The Swedish Energy Agency has developed a new systematic method for planning the disconnection of electricity for short-term electricity shortages. This method is called **Styrel - control of electricity to priority users, and aims to the greatest extent possible, identify and prioritize electricity users that are important for society to function**. It may include hospitals, emergency services and electronic communications, but also electricity users such as responsible for water and wastewater systems to work in case of short-term electricity shortages. The project started 2004 and can be considered finalised as the first national planning session was conducted in 2011. During 2011 all 290 municipalities, 20 county administration boards and 170 power distribution companies in Sweden have been identified and planned for prioritizing. Legislation has been adjusted, the Electricity Act, a separate regulation for Styrel and so on. The Swedish Energy Agency is responsible for the coordination of Styrel.

NordBER, the Nordic Contingency Planning and Crisis Management Forum, continues its work. A renewed Letter Of Intent was signed by all Nordic Transmission System Operators and Power Emergency Authorities in 2010. The scopes of cooperation includes cross-border contingency planning and crisis management; risk- and vulnerability assessment; a mutual contingency plan; resource planning and sharing of information, communication and experience exchanges as well as a mutual training- and exercise programme. Cross-border support during real crisis has so far been limited, but do exist.

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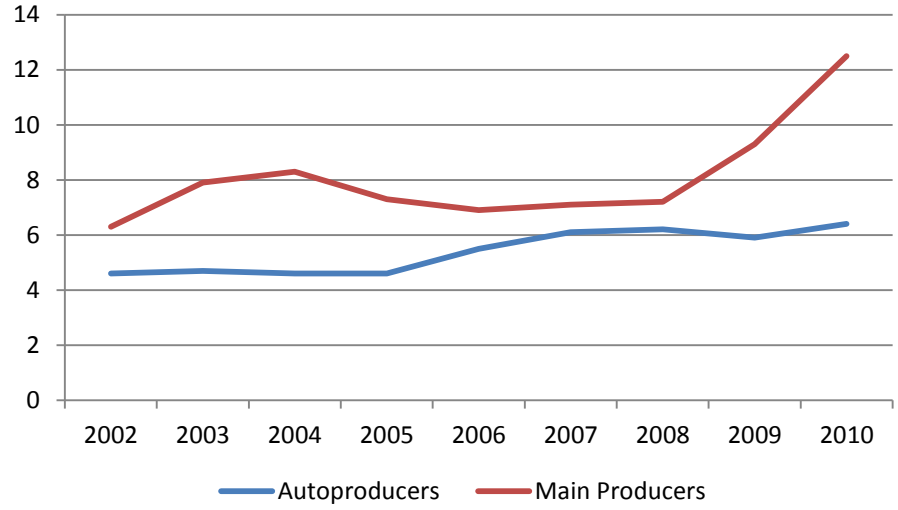
9-S CHP development

Sweden has seen a steady growth in CHP produced electricity over the years, with particularly high rates the last two years (see figure 16). Compared to countries like Finland cogeneration is still relatively small in Sweden, with the consequence of heavy reliance on hydro- and nuclear power instead. The long term trend for cogeneration is however increasing.

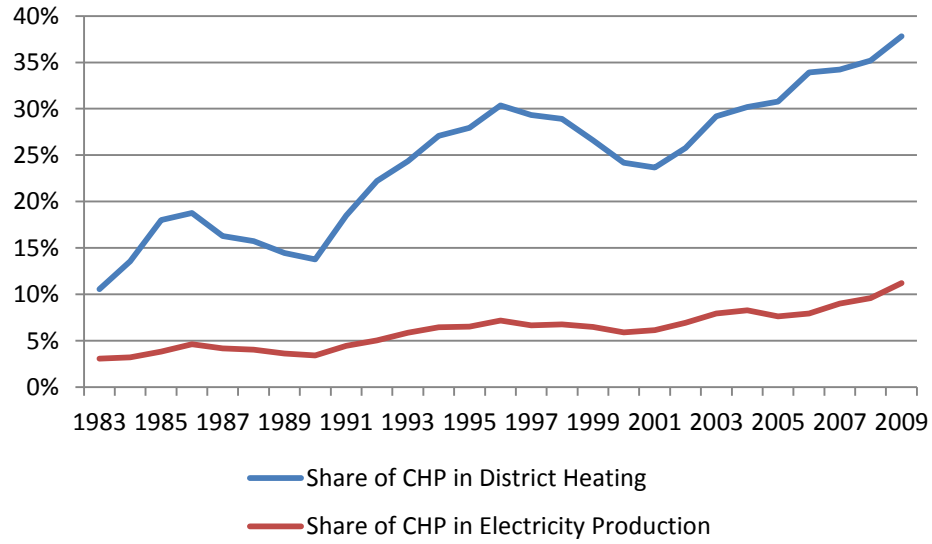
Figure 13: CHP generated electricity, TWh



Source: Elåret 2010

All CHP production is high efficient CHP and as shares of total electricity and heat production cogeneration has increased considerably. Year 2009 CHP-heat accounted for 38 % of all district heating which is almost threefold since 1990. The share of CHP in electricity amounted to 11 %, including transmission losses, as compared to only 3,4 % in 1990 (see figure 17).

Figure 14: Share of CHP generated electricity and heat in total consumption



Note: Industrially produced (and used) heat is not capured by this statistics.
Source: Energiindikatorer 2011 (ER2011:12)

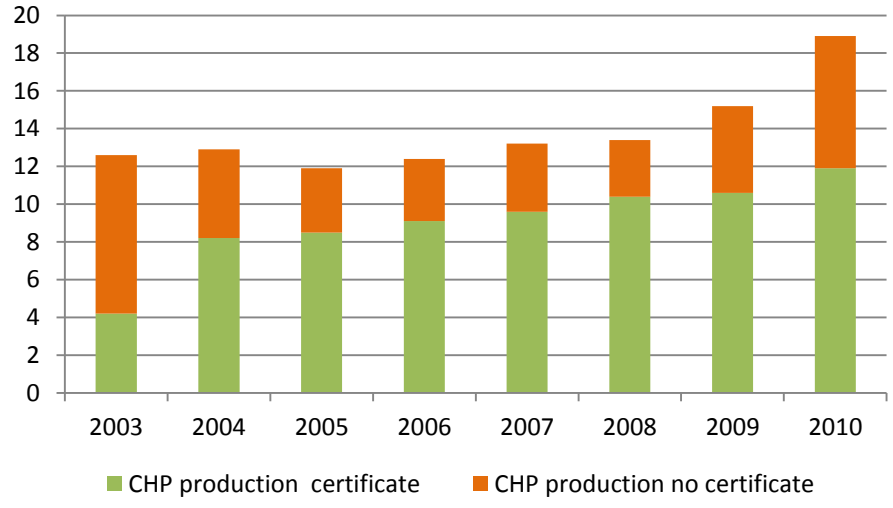
Promotion of CHP development

Historically low electricity prices previously made it unprofitable to invest in CHP. Increased electricity prices coupled with a number of favourable policy measures and instruments has stimulated a substantial CHP growth. An important policy measure is a substantially lower CO^2-taxation, within EU-ETS, for heat production in CHP plants compared to heat production only. CHP-heat meets a 7 % carbon tax rate (of 105 öre/kg CO^2) instead of the 94 % as seen in heat production only. Furthermore, energy taxation for CHP-heat is slightly lower, 2.4 öre/kWh as compared to 8 öre/kWh for heat only production. The CHP carbon tax level was set down 1 January 2012, from 15 % while the energy taxation is entirely new. Outside the EU-ETS CO^2-taxation for CHP heat production was increased from 21 % to 30 %.

Another important policy measure is the electricity certificates system launched in May 2003. The effects of the system initially meant a shift from fossil to biofuel and the last few years a total increase in CHP investments. Figure 18 shows total CHP production and shares receiving electricity certificates.

Other measures indirectly promoting CHP development are previous investment programmes LIP and KLIMP[23], where municipalities could apply for subsidies for ecologically sustainable and environmentally friendly projects. A consequence was considerable investments in district heating involving around 260 projects. [24]

Figure 15: Production of CHP receiving electricity certificates, TWh



Source: Energimyndigheten
Note: Year 2003 is for May-December.

[23] LIP=Local Investment Programme. KLIMP= Climate Investment Programme
[24] Incitament för ökad kraftvärmeproduktion, Rapport 2009:9

References:

- Elcertifikatsystemet 2011- ET2011:32
- Regeringens proposition 2009/10:41, Vissa punktskattefrågor med anledning av budgetpropositionen för 2010.
- Energiläget i siffror 2011 - ET 2011:42
- Energiindikatorer 2011 - ER2011:12
- Incitament för ökad kraftvärmeproduktion - Rapport 2009:9
- Elåret 2010, Svensk Energi

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10. District Heating

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10-A District Heating – Industry Structure

Industry structure

Up until the mid-1990s, district heating companies were mainly run by municipalities and district heating was sold at cost price. The electricity market reform in 1996 brought demands, however, for district heating to be operated on a commercial and competitive basis. The reform initiated a change where many municipality-owned companies came to pass into private ownership. Between 1990 and 2004, around 70 municipal energy companies with district heating operations were sold to private companies but since then privatization has halted. Municipal district heating companies currently provide 63% of the combined delivery of district heating in Sweden, while private and state-owned district heating companies account for 37%. There are only eight municipalities where

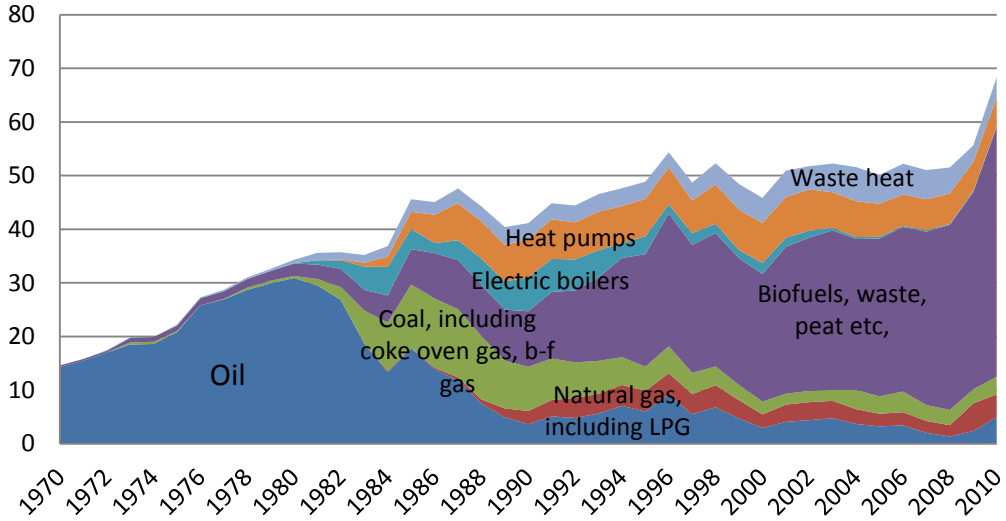
district heating operations are under municipal administration and where, in accordance with the Swedish Local Government Act, these operations must be run at cost price. However, of the total delivery of district heating, these eight local governments account for just 0.3 TWh. In a survey of 150 companies, 42 stated that they had profit maximization as a business principle, while 16 stated the cost pricing principle. The remaining companies included municipal and political interests and objectives in their strategy. In total, there are 200 district heating companies on the market.

Technology and Fuel Sources

Since the 1970s, there has been a major transition towards the use of renewable fuels. In 2010, wood fuels accounted for 46%, waste for 17%, peat for 4% and waste heat for 5% of the energy used to produce district heating in Sweden. The use of waste has increased over the past decade, and in several Swedish cities, heat from waste incineration forms the foundation of district heating. The increase is a result of the 2002 ban on combustible waste in landfills and a similar ban regarding organic waste in 2005. It is primarily the decrease in electric boilers, and to some extent heat pumps, in the district heating system that indicates a reduction in electricity use in the district heating sector. Figure 19 shows the energy supplied to district heating between 1970 and 2010. Due to improved technology and network utilization as well as an increased proportion of ready heat, distribution and conversion losses in the district heating system have decreased considerably over the years.

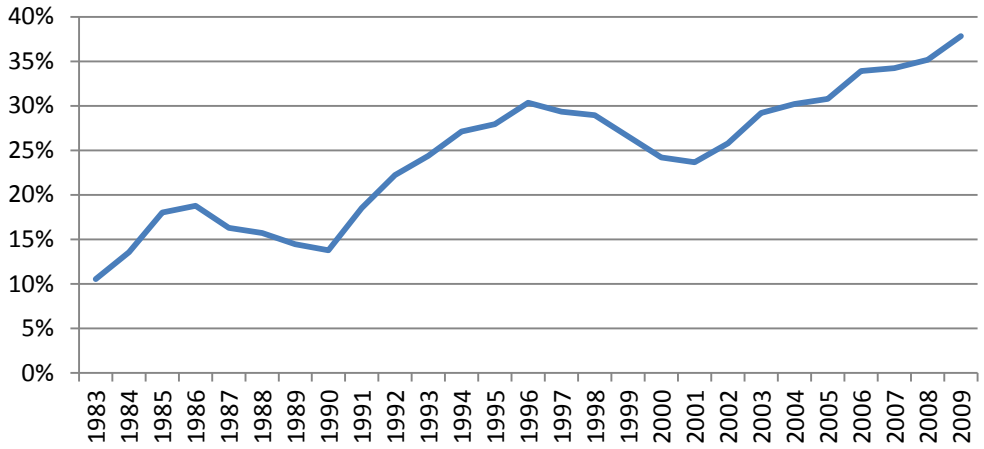
The increase in CHP production over the years is a notable change in the development of the district heating market. CHP development is primarily fuelled by the electricity certificate system as well as substantially lower rates of CO2-taxation in relation to heat-only boilers. In 2009 CHP amounted to 38 per cent of the total district heating generated (see figure 20).

Figure 16: Energy input for district heating, 1970–2010, TWh



Source: Energiläget i siffror 2011 (ET 2011:42)
Note: The sharp increase in DH production 2010 is primarily due to an extremely cold winter.

Figure 17: Share of CHP in District Heating



Source: Energiindikatorer 2011 (ER2011:12)

Previous IDR recommendation

The government of Sweden should:

- *Ensure cost-reflective consumer prices and provide incentives for efficient operation and investment by regulating the district heating sector, preferably ex ante.*

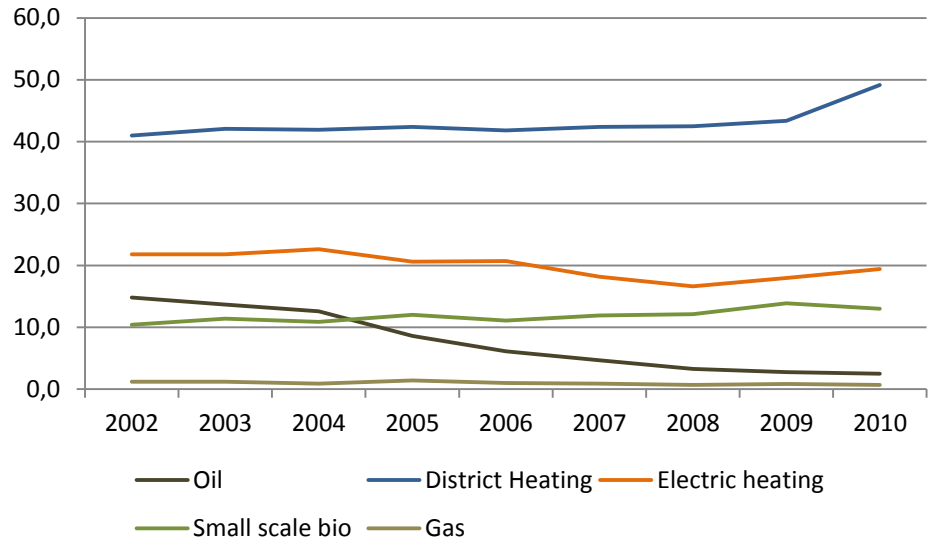
Action taken:

In March 2012 the Swedish government proposed four measures to strengthen consumer and industrial waste heat suppliers' position in the district heating market. Among them a price change test was proposed. Such a regulation protects consumers from unfair rate hikes. Furthermore, it was proposed that heat suppliers will be offered a regulated access to the distribution network. Both of these proposals will lead to greater efficiency and in the long run benefit customers (see section 10-C).

10-B District Heating – Supply and Demand –

District heating has existed in Sweden since the 1950s. District heating is the leading heating method for multi dwelling buildings and non-residential premises, taking 93% and 83% of the market shares respectively in 2010. In the market for one- and two-dwelling buildings, district heating has a share of 16 %. Figure 21 shows the dominance of district heating in relation to other heating alternatives. Heat pumps are not included in the figure and contribute with approximately 14 TWh 2009.

Figure 18: Total energy use for heating and hot water 2002-2010, TWh



Source: Energistatistik för småhus, flerbostadshus och lokaler 2010, ES 2011:11
Note: The figure does not include the service sector or leisure houses.

The distribution of district heating can be considered a natural monopoly as the net owner largely dictates the terms. In smaller areas where large production plants supplies all customers, production can also be considered a natural monopoly. The only competition comes from alternative heating forms that may, or may not, be possible, and or optimal, for the consumer to choose. There are also lock-in effects as consumers who have invested in connection fees to the net

are reluctant to change heating system and be unable to recover their investment. Changing to e.g. (ground source) heat pumps, if possible, would also entail significant renewed investment costs. In around 40 % of the municipalities it would (given the possibility) prove profitable to change heating system from district heating[25].

10-C District Heating – Regulation and Prices

Pricing

There are significant differences in the price of district heating. . The price in the most expensive municipality is more than twice the price in the cheapest. These price differences are due to factors such as ownership structures in the district heating companies, profitability requirements, fuel-allocation as well as geographical conditions for district heating installations. A given customer's choice of options on the heating market depends largely, then, on where the customer lives. The lowest cost for district heating can be found in Luleå (85, 1 SEK/m²) while the most expensive district heating can be found in the municipality of Falkenberg (189, 2 SEK/m²). Between 2006 and 2011 as many as 34 district heating companies have increased their prices by more than 30 %[26].

Regulation

Since 2008, the district heating market in Sweden has been governed by the District Heating Act[27]. The Energy Markets Inspectorate is the supervisory authority in charge of enforcing the provisions of the District Heating Act. District heating companies have, for example, an obligation to negotiate certain contractual terms with individual district heating customers. If the parties are not able to come to an agreement themselves, they may apply to the District Heating Board for mediation. The Board also mediates between district heating companies and other actors wishing to gain access to the distribution networks.

In order to increase transparency and avoid overpricing on the district heating market a number of regulations have been put in place. Since 2007 companies are required to submit separate accounts for their various activities in order to avoid cross subsidization. This measure has, however, not been an effective method. On 1 October 2009, the Energy Markets Inspectorate's regulations[28] entered into

[25] Fastigheten Nils Holgerssons underbara resa genom Sverige - En avgiftsstudie för 2011 (2011)
[26] Fastigheten Nils Holgerssons underbara resa genom Sverige - En avgiftsstudie för 2011 (2011)
[27] (Fjärrvärmelag (2008:263))
[28] EIFS 2009:2

force, defining the companies' obligations to provide accurate price information. In 2009, district heating companies also began reporting operational and business details to the Energy Markets Inspectorate.

Proposal to legislated third party access

Current regulations governing district heating operations mean that only owners of a district heating network have the right to access the network. As a consequence the possibility of legislating for third-party access (TPA) has been investigated. The TPA investigation (SOU 2011:44) proposes an opening up of the district heating networks for access to competing producers and suppliers. Where competition arises, a distinction between the various operations of distribution, production and supply will then be made. A central idea behind legislated third-party access is to help open up the district heating market to more waste heat from the industry. The TPA investigation however finds that it is unclear how district heating prices will be affected if the legislative proposal is adopted. The cost of realizing these objectives in relation to the energy- and environmental goals has furthermore not been investigated.

Proposed measures for developed district heating markets for the benefit of consumers and waste heat suppliers

In March 2012 the Swedish government proposed four measures to strengthen consumer and industrial waste heat suppliers' position in the district heating market given the difficulty of achieving effective competition in the district heating market.

- A price change test is introduced in order to protect customers from unreasonable price hikes.
- Regulated access for residual heat suppliers and other heat producers
- Accounting for residual heat potential in the design of new district heating production
- Equality Policy to customers in the same class of customers

These regulations protect consumers from unfair rate hikes and will lead to greater efficiency and in the long run benefit customers.

Subsidies

Between 2006-2010 subsidies for conversion to district heating, ground source heat pumps or small scale bio installations from oil or direct electric heating could be obtained. The subsidies for conversions from direct electric heating totalled at around 455 MSEK for the whole period whereof 75 % went to district heating

conversions. Around 450 MSEK was paid to conversions from oil heating (2006-2007) but only around 20 % went to district heating installations.

References:

- Analys av fjärrvärmeföretagens intäkts- och kostnadsutveckling - EIR 2011:08
- Energiläget i siffror 2011 - ET 2011:42
- Energiindikatorer 2011 - ER2011:12
- Fjärrvärme i konkurrens -SOU 2011:44
- Uppvärmningen i Sverige 2011 -EI R2011:06
- Energistatistik för småhus, flerbostadshus och lokaler 2010 - ES 2011:11
- Fastigheten Nils Holgerssons underbara resa genom Sverige - En avgiftsstudie för 2011 (2011)

11. Nuclear Energy

11-A Policies overview including major changes since previous IDR

In 1987 the Act on Nuclear Activities was amended to prohibit the issue of a licence for the construction of a nuclear power reactor. The Act on the Phasing-out of Nuclear Power was adopted in 1997.

In 2010 the Parliament approved two bills which meant a considerable change as compared to previous years' policy regarding nuclear power, i.e.:

- It will be possible to replace old reactors with new ones, given that the old one is permanently closed and the new reactor is situated on the same locations as the old one.
- Nuclear power industry was given unlimited financial liability in the case of a serious accident.
- Nuclear industry will have to carry all the costs associated with nuclear power, i.e. there will not be any form of direct nor indirect public subsidy

- The policy leaves it up to the power industry to decide whether it is commercially interesting to invest in new reactors, given that nuclear industry will not receive any form of, subsidy whereas renewable energy will be continuously supported.

11-B Previous IDR recommendations

The government of Sweden should:

- *Clarify its position on the role of nuclear energy in the medium and long term in order to provide the industry with a clear and stable framework for investing in new generating capacity.*

  The government's bill in 2010 has defined the conditions for new nuclear power. It is now clear that industry itself can decide which production technology it wish to employ, given the commercial conditions that follows from a policy which does not allow any form of subsidy to nuclear power and focus its support on renewable energy.

- *Maintain a strong and independent safety authority to ensure that nuclear power plants in operation enjoy excellent safety and reliability performance.*

  In 2008 the two authorities the Swedish Nuclear Power Inspectorate and the Swedish Radiation Protection Institute were strengthened and merged when the new agency was established; The Swedish Radiation Safety Authority.

- *Ensure that R&D, education and training programmes in the field of nuclear energy provide human capacity for the safe operation of existing nuclear power plants during their entire lifetime.*

  The government's recent bill on R&D and innovation contains a section specifically targeting the need for human resources in the nuclear sector.

- *Pursue the timely commissioning of a spent fuel repository.*

  All relevant financial and regulatory legislation regarding the final repository is in place. The nuclear operators have through the Swedish nuclear Waste Management Company (SKB) filed an application for building a final repository. The application is currently under review by the Swedish Radiation Safety Authority (SSM) and will together with a statement in due time be handed over to the government for decision. In addition to this procedure SKB also has filed an application to the Environmental court in accordance with the Environmental Act.

11-C Nuclear Industry Structure

At present, in Mars 2012, there are 10 nuclear power reactors in operation in Sweden. The Swedish nuclear sector also includes a fuel factory, two waste storage facilities and one waste treatment facility.

The ownership of the Swedish nuclear power plants (NPPs) is to a large extent characterised by cross ownership as shown in Figure 19, below. During 2008 and 2009 the conditions for the present cross ownership was analysed by a group of government officials. However, in 2010, after discussions with all involved parties, it was concluded that no further regulations regarding ownership should be introduced.

The main owners of the Swedish NPPs are Vattenfall AB, E.ON Sweden AB and Fortum. The Swedish State owns 100 % of the stocks in Vattenfall AB, E.ON Sweden AB is 99,9% owned by E.ON AG and Fortum is listed on the NASDAQ OMX Helsinki with the Finish Prime Minister´s Office as the major owner with a share of 50.76 %.

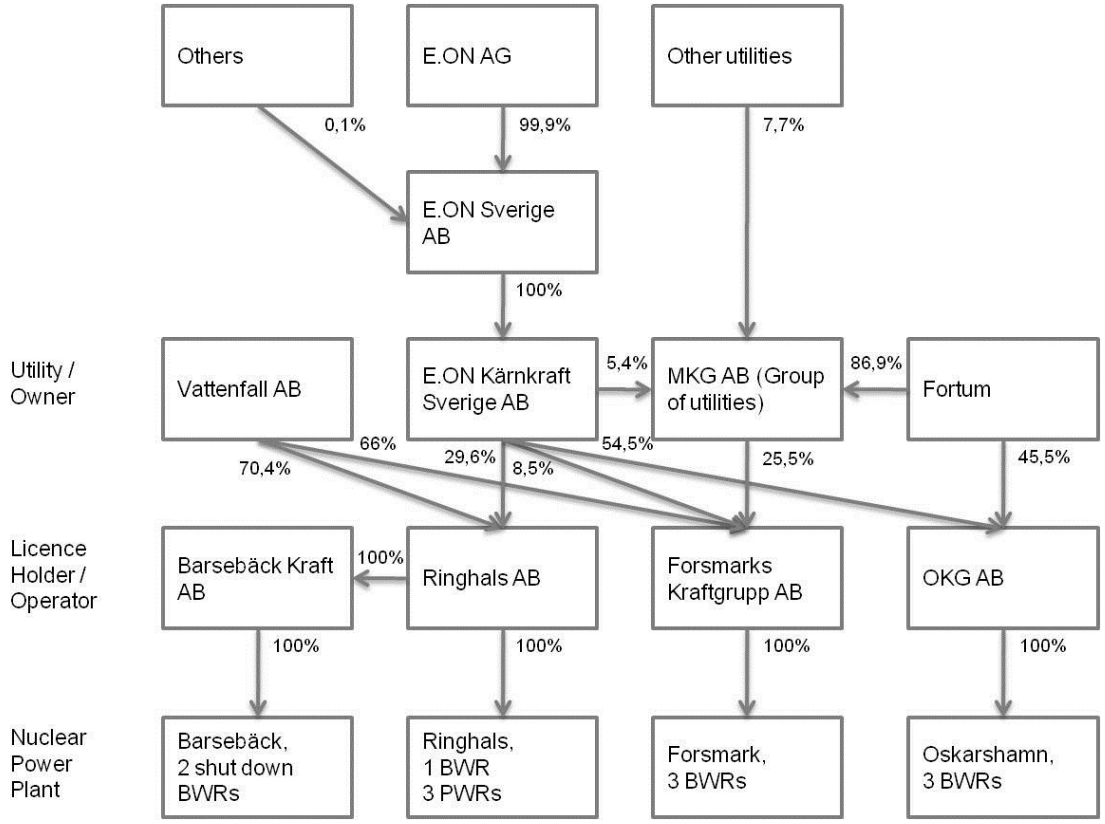


Figure 19. Utility structure and owner relations.

The nuclear fuel factory situated in Västerås, Sweden, is operated by Westinghouse Electric Sweden AB and owned by the Toshiba Power Systems Company. The nuclear fuel factory in Västerås is responsible for the entire chain from research and development to manufacturing of nuclear fuel for Boiling Water Reactors and Pressurized Water Reactors, as well as control rods and fuel channels for BWR plants including codes for core surveillance. The factory produces approximately 400 tons of UO_2 fuel for BWRs and PWRs per year. In the conversion of UF_6 into UO_2 powder, the capacity as well as the plant license is limited to 600 tons UO_2.

The Swedish Nuclear Fuel and Waste Management Company (SKB) is handling the management and disposal of all radioactive waste from Swedish NPPs. SKB is a jointly-owned company which performs most of its services on behalf of its owners, the utilities that operate the Swedish NPPs. The owners are Vattenfall AB (36 %), E.ON Kärnkraft Sverige AB (12 %), OKG Aktiebolag (22 %) and Forsmarks Kraftgrupp AB (30 %). The Company has three facilities in Sweden. An interim storage facility for spent nuclear fuel

(Clab) near Oskarshamn, a final repository for short-lived radioactive waste (SFR) in Forsmark and a main office is in Stockholm.

The Studsvik facility for treatment of low and intermediate level waste situated outside Nyköping in Sweden, is operated by the publicly traded company Studsvik AB. The major owners are Familjen Karinen (21.5 %), Briban Invest AB (15.6 %), Allianz Global Inv. (8.7 %) and Credit Agricole Suisse SA (4.2 %). The purpose of the waste treatment is mainly to achieve volume reduction and stabilization of waste before final disposal. The melting and incineration facilities in Studsvik process dry and metallic waste by incineration and melting. The waste is mainly from nuclear facilities in Europe.

11-D Nuclear fuel sources

The uranium present in Swedish nuclear power plants (NPPs) originates from different parts of the world depending on the utility, the unit and the year (the fuel cycle).

At the Oskarshamn NPP the major quantity of the uranium present in the units (Mars 2012) originates from Canada (Cameco) and is enriched in Germany, Holland or UK (by Urenco).

At the Ringhals NPP and Forsmark NPP the major quantity of the uranium present in the units (Mars 2012) originates from Australia and is enriched within EU.

11-E Waste management – low and intermediate level

The radioactive waste originates from the nuclear power industry as well as medical use, industry, research and consumer products. Past research activities have also generated some waste, which are either stored or have already been disposed. An overview of the Swedish program for management and disposal of spent nuclear fuel and radioactive waste is given in Appendix 1, Table 20. An overview of the management system for spent fuel and nuclear waste is given in Appendix 1, Figure 20.

Policy

The Swedish radioactive waste management policy is not explicitly expressed in single document. The Swedish Parliament has on several occasions declared that Sweden supports and will follow the principle of each country’s responsibility to take care of and dispose of radioactive waste produced within the country.

Disposal, as well as interim storage, of foreign radioactive waste in Sweden is prohibited.

Legal & regulatory framework

The management of spent fuel and nuclear waste is regulated by a series of statutory provisions, of which the three main legislative instruments are:

- The Act on Nuclear Activities (1984:3), which defines the licensing requirements for the construction and operation of nuclear facilities and for handling or using nuclear materials (including radioactive waste).
- The Radiation Protection Act (1988:220), which defines the licensing requirements for radiation protection and for radiological work.
- The Act on Financial Measures for the Management of Residual Products from Nuclear Activities (2006:647) which deals with the main financial aspects, and defines the responsibilities pertaining to the management and disposal of spent nuclear fuel and radioactive waste.

These are the basic principles for the structure of the Act (1984:3) on Nuclear Activities. They are also contained in the Act (2006:647) on Financial Measures for the Management of Residual Products from Nuclear Activities.

Under the Act on Nuclear Activities the holder of a license to operate a nuclear reactor is primarily responsible for the safe handling and disposal of spent fuel and radioactive waste produced by the reactor. In addition the holder is responsible, under the Radiation Protection Act, to take all measures and precautions necessary to prevent or counteract injury to human health and the environment by radiation.

The Act on the Financial Measures for the Management of Residual Products from Nuclear Activities is an essential part of the Swedish nuclear waste management system since it lays down the principles for the financing of expenses for decommissioning and disposal of spent nuclear fuel and nuclear waste.

The Environmental Code (1998:808) is also of importance, in particular for the siting and construction of new facilities since amongst other things it regulates the environmental impact statement that must accompany a license application. Any new nuclear facility must be licensed according to both the Act on Nuclear Activities and the Environmental Code. In both cases the Government grants the license on the basis of recommendations and reviews of the competent authority.

Waste management

The general objectives of the waste management at the locations of the nuclear power plants (NPPs) are to:

- minimize the amount of waste,
- ensure that all nuclear waste is handled and conditioned for disposal according to existing regulatory requirements, and
- accomplish the waste management in a safe and cost-efficient way with the least possible impact on human health and the environment.

Waste minimization is in certain cases substituted by optimising the waste generation, in which consideration is taken to radiation doses and costs. Minimization of the amount of waste is, for example, achieved by reducing the amounts and kinds of materials brought into radiological controlled areas, and by separation of waste at source.

Waste arising outside of the nuclear fuel cycle may, when needed and if appropriate, be disposed in disposal facilities for nuclear fuel cycle wastes.

There is no legally defined waste classification system in Sweden for nuclear or radioactive waste. There are, however, established waste acceptance criteria for different disposal routes of nuclear and radioactive waste. These disposal routes differ between activities within the nuclear fuel cycle and outside the nuclear fuel cycle depending both on the different types of material being handled and also on which of the different routes that have been established by taking repositories into operation. For the established disposal routes, including clearance, waste acceptance criteria have been set up that are being expressed dose rate limits and activity concentration.

Operation

The four utilities operating nuclear power reactors in Sweden have formed a special company, the Swedish Nuclear Fuel and Waste Management Company

(SKB), to assist them in executing their responsibilities. Thus, SKB is responsible for all handling, transportation and storage of spent nuclear and radioactive waste outside the NPPs. Furthermore, SKB is responsible for the planning and construction of all facilities required for the management of spent nuclear fuel and radioactive wastes, and for such research and development work as is necessitated by the provision of such facilities (R&D programmes). These R&D programmes have to be reported to the Government, or an authority designated by the Government, and reviewed by the authorities every third year. The programme should include a comprehensive description of the measures taken to ensure safe handling and disposal of spent fuel and nuclear waste. SKB is further responsible for coordination and investigations regarding the costs associated with nuclear waste and future decommissioning.

Storage and disposal facility for radioactive waste

The intermediate and low-level waste at the NPPs is stored temporarily in rock caverns or storage buildings awaiting transportation to the repository SFR (owned and operated by SKB) located near the Forsmark NPP. Prior to shipping to SFR the types of waste packages have to be approved by the Swedish Radiation Safety Authority with regard to safety during transport and for disposal (waste acceptance).

The low and intermediate level waste (LILW) is divvied into two categories:

- Intermediate-level waste
  This type of waste is dominated by filters and spent ion exchange resins, which are commonly solidified with cement or bitumen in steel drums, or in moulds of reinforced concrete or carbon steel. The cement or bitumen immobilises the waste, while the moulds contain the waste forms, and in the case of concrete moulds also provide radiation shielding. Some intermediate-level resins with lower activity content are packaged in concrete tanks and dehydrated without solidification.

  Metal scrap, and other kinds of solid wastes above a certain level of activity, also belong to this category and are packaged in concrete or steel moulds, compacted, if possible, and grouted with concrete.

- Low and very low-level waste
  After segregation, with respect to activity content and combustibility, the low-level waste is compacted into bales or packaged in drums or cases, which are placed in standard freight containers. Some waste with very low activity level is disposed of in shallow land burial sites at the NPPs. To minimize infiltration the waste is covered with bentonite liners and/or

compacted clays. The sealing layers are protected by an approximately 1 meter thick layer of moraine. Some combustible low-level waste is shipped to Studsvik, where it is incinerated in a special facility. The ashes are collected in steel drums, which in turn are grouted with concrete in overpacks of steel.

Most of the LILW are conditioned (solidified, compacted, etc.) at the point of origin, i.e. at the reactor sites. Some wastes are sent to Studsvik's waste treatment facilities for incineration or melting.

Short-lived LILW is treated and packaged according to a standardized system with predefined waste type descriptions (WTD) and disposed of in the disposal facility for operational waste (SFR), in rock caverns in crystalline bedrock. WTD's are subject to approval by the regulatory authority. The disposal facility consists of five different caverns, and wastes are directed to different parts of the disposal facility depending on, e.g. the activity content and chemical characteristics.

Long-lived LILW will be disposed of in a disposal facility in rock caverns in crystalline bedrock. Until the disposal facility has been constructed the long-lived waste will be stored either at the NPP, at the Studsvik site or in storage pools in the interim storage for spent nuclear fuel (Clab). However, SKB investigates the possibility to establish an interim storage of long-lived low- and intermediate level waste in the extended SFR that is currently under discussion.

SFR is designed for the disposal of short-lived low and intermediate level radioactive waste from the Swedish NPPs and Clab, and for similar waste from other industry, research and medical usage which is treated in Studsvik before being transported to SFR. SFR is situated approximately 140 kilometers north of Stockholm, close to the Forsmark NPP. SFR consists of four rock caverns and a silo. The facility is situated in crystalline bedrock, approximately 50 m below the seabed at a depth of 5 m. Construction started in 1983 and it was taken into operation in 1988. The total capacity is 63 000 m^3 and 33 871 m^3 had been used by 2010-12-31. SKB is planning an extension of SFR in order to dispose of additional operational waste and waste from future decommissioning of NPPs. SKB intends to submit a license application in 2013 and operation is planned to commence in 2020. The SFR facility is schematically illustrated in Appendix 2, Figure 21.

11-F Waste management – high level

Spent fuel in Sweden emanates mainly from four commercial nuclear power plants (NPPs), one material testing reactor and one research reactor. An overview of the management system for spent fuel and nuclear waste is given in Appendix 2, Figure 1.

Policy

The Swedish spent fuel policy is not explicitly expressed in single document. The rationales for the management system for spent fuel and nuclear waste are based on basic principles that have been derived from extensive discussions in the Swedish parliament. Thus, the national policy and strategy for the management of spent nuclear fuel and nuclear waste has been expressed and supported by the parliament by means of four basic principles:

1. The expenses for the disposal of spent nuclear fuel and nuclear waste are to be covered by revenues from the production of energy that has resulted in these expenses.
2. The reactor owners are to safely dispose of spent nuclear fuel and nuclear waste.
3. The state has the ultimate responsibility for spent nuclear fuel and nuclear waste. The long-term responsibility for the handling and disposal of spent nuclear fuel and nuclear waste should rest with the state. After a repository has been closed, a requirement should be established to ensure that some kind of responsibility for and supervision of the repository can be made and maintained for a considerable time. A government authority could assume responsibility for a closed repository.
4. Each country is to be responsible for the spent nuclear fuel and nuclear waste generated in that country. The disposal of spent nuclear fuel and nuclear waste from nuclear activities in another country may not occur in Sweden other than in an exceptional case.

Another basic prerequisite as regards spent fuel management is that reprocessing will not take place. Thus, spent nuclear fuel is in practice considered as, and treated as, waste, although it is not legally defined as waste until disposed of in a repository. However, reprocessing agreements for reprocessing spent nuclear fuel from civilian NPPs were made with United Kingdom Atomic Energy Agency (now the British Nuclear Fuel Limited, BNFL) in 1969 and Compagnie Générale des Matières Nucléaires (COGEMA) between 1978, before current policy regarding the management of spent nuclear fuel was established in the late 1970's.

However, only a small number of fuel elements were in fact shipped for reprocessing and the agreements were terminated in the early 1980's.

Legal & regulatory framework

The management of spent fuel and nuclear waste is regulated by a series of statutory provisions, of which the three main legislative instruments are:

- The Act on Nuclear Activities (1984:3), which defines the licensing requirements for the construction and operation of nuclear facilities and for handling or using nuclear materials (including radioactive waste).
- The Radiation Protection Act (1988:220), which defines the licensing requirements for radiation protection and for radiological work.
- The Act on Financial Measures for the Management of Residual Products from Nuclear Activities (2006:647) which deals with the main financial aspects, and defines the responsibilities pertaining to the management and disposal of spent nuclear fuel and radioactive waste.

These are the basic principles for the structure of the Act (1984:3) on Nuclear Activities. They are also contained in the Act (2006:647) on Financial Measures for the Management of Residual Products from Nuclear Activities.

Under the Act on Nuclear Activities the holder of a licence to operate a nuclear reactor is primarily responsible for the safe handling and disposal of spent fuel and radioactive waste produced by the reactor. In addition the holder is responsible - under the Radiation Protection Act - to take all measures and precautions necessary to prevent or counteract injury to human health and the environment by radiation.

The Act on the Financial Measures for the Management of Residual Products from Nuclear Activities is an essential part of the Swedish nuclear waste management system since it lays down the principles for the financing of expenses for decommissioning and disposal of spent nuclear fuel and nuclear waste.

The Environmental Code (1998:808) is also of importance, in particular for the siting and construction of new facilities since amongst other things it regulates the environmental impact statement that must accompany a licence application. Any new nuclear facility must be licensed according to both the Act on Nuclear Activities and the Environmental Code. In both cases the Government grants the licence on the basis of recommendations and reviews of the competent authority.

Spent fuel management

The Act on Nuclear Activities, requiring licence-holders for nuclear activities to ensure the safe handling and disposal of nuclear waste arising from the activities or nuclear material arising therein that is not reused. As regards spent nuclear fuel and nuclear waste, the licensee for a nuclear power reactor shall, in cooperation with the other holders of a licence for the operation of nuclear power reactors, establish and carry out a research and development (R&D) programme for the safe handling and disposal of spent fuel and nuclear waste.

As regards costs for management and disposal of spent nuclear fuel and nuclear waste, the licensee for a nuclear power reactor is, in cooperation with the other holders of a licence for the operation of nuclear power reactors, responsible for paying the costs for management and disposal of spent fuel and nuclear waste.

The Swedish Radiation Safety Authority was assigned by the government to compile an integrated account for all spent nuclear fuel and radioactive waste generated both within and outside the nuclear fuel cycle, to identify and propose any improvement to the management and disposal activities. The assignment was reported back to the Government 30 June 2009. The report confirms that management and disposal of spent nuclear fuel and nuclear waste (i.e. radioactive waste from the nuclear fuel cycle) is satisfactory. According to the report, no specific action is needed in addition to already existing practices according to existing legal and regulatory framework, i.e. the Act (1984:3) on Nuclear Activities, the Act (2006:647) and the Ordinance (2008:715) on Financial Measures for the Management of Residual Products from Nuclear Activities and the Act (1988:1597) on Financing of Certain Radioactive Waste etc. (the Studsvik Act). However, in order to improve the situation, the report proposes actions within the following areas:

- Interim storage and disposal of radioactive waste for radioactive waste generated outside the nuclear fuel cycle.
- Action plans for radioactive material (outside the nuclear fuel cycle) which unintentionally ends up adrift without regulatory control.

- Clarification of responsibilities in the legislation.
- Preservation of information as regards waste disposal facilities.

SSM supervises the management of spent nuclear fuel at the NPPs during the ordinary inspections of safety and security. These procedures fall under the general management of safety. The issues of contamination of spent nuclear fuel containers, however, were/are the responsibility of radiation protection and transport safety.

Operation

Under Swedish law, the holder of a licence to operate a nuclear facility is primarily responsible for the safe handling and disposal of spent nuclear fuel and radioactive waste, as well as decommissioning and dismantling of the facility. The four utilities operating nuclear power reactors in Sweden have formed a special company, the Swedish Nuclear Fuel and Waste Management Company (SKB), to assist them in executing their responsibilities. Thus, SKB is responsible for all handling, transportation and storage of spent nuclear and radioactive waste outside the NPPs.

Furthermore, SKB is responsible for the planning and construction of all facilities required for the management of spent nuclear fuel and radioactive wastes, and for such research and development work as is necessitated by the provision of such facilities (R&D programmes). These R&D programmes have to be reported to the Government, or an authority designated by the Government, and reviewed by the authorities every third year. The programme should include a comprehensive description of the measures taken to ensure safe handling and disposal of spent fuel and nuclear waste. SKB is further responsible for coordination and investigations regarding the costs associated with nuclear waste and future decommissioning.

Storage and disposal facility for spent fuel

At the Swedish NPPs, the spent nuclear fuel is stored in the fuel pools for about a year before it is transported to the central interim storage facility for spent nuclear fuel (Clab). The safety and security measures taken at the NPPs do not differentiate between spent or partially spent fuel. The process of loading spent fuel into transport containers (weight: 80 tonnes, thickness: 32 cm of steel, length: 6.15 m, diameter: 1.95 m, capacity: 17 BWR-elements or 7 PWR-elements) is closely monitored and carefully performed in order to guarantee a contamination-free surface of the container. Special procedures are rigorously followed to achieve the desired quality control. Spent nuclear fuel from the Forsmark NPP and the Ringhals NPP (and previously the Barsebäck NPP), is transported with

specially designed transport vehicles to the site harbours and shipped to the central storage for spent nuclear fuel in Oskarshamn. Spent nuclear fuel from the Oskarshamn NPP is transported directly to Clab by means of specially designed transport vehicles.

The central interim storage (Clab) is situated adjacent to the Oskarshamn NPP. The facility consists of two parts, one building above ground for unloading spent fuel assemblies from transport casks, and one underground part for storage with a rock cover of about 25-30 meters. The storage part consists of two caverns approximately 120 metres, each containing five storage pools. Construction started in 1980 and the facility was taken into operation in 1985 with a storage capacity of 5 000 tonnes of spent fuel. The current total storage capacity is approximately 8 000 tonnes of spent fuel, and 5 222 tonnes were being stored at the end of 2010. An overview of the Clab facility is given in Appendix 2, Figure 22.

The capacity of the interim storage for spent nuclear fuel (Clab) was increased in 2008 and the storage capacity is now sufficient to provide for storage of all spent fuel to be produced in Swedish NPP's, i.e. 50-years operation of the reactors in Ringhals and Forsmark and 60 years operation for the reactors in Oskarshamn.

According to current plans, fuel elements after a storage period in Clab of about 30-40 years will be transported to the spent nuclear fuel disposal facility. The main alternative for disposal of spent fuel, involves emplacement of fuel elements in copper canisters (corrosion resistance) with cast iron inserts (mechanical strength). The canisters will be embedded in bentonite clay (protection against corrosion and rock movements, prevent water penetration and leakage of radioactive substances) in individual deposition holes at a depth of about 400-700 m in the bedrock (maintains the technical barriers over long time, isolates the spent fuel from human beings and the environment). An overview of the planed spent nuclear fuel disposal facility is given in Appendix 2, Figure 23.

The siting process for the disposal facility ended in June 2009, when the board of SKB decided to choose Forsmark as the site for the disposal facility for spent nuclear fuel. In March 2011 SKB submitted a license application for siting and construction of the disposal facility, which is expected to commence operation in 2025. SKB is applying for a permit to build and operate a nuclear fuel disposal facility in Forsmark and an encapsulation plant in Oskarshamn.

11-G Regulatory Institutions

The Swedish Radiation Safety Authority

The Swedish Radiation Safety Authority (SSM) was established on July 1, 2008. The SSM took over the responsibility and tasks from the Swedish Nuclear Power Inspectorate (SKI) and the Swedish Radiation Protection Institute (SSI) when these were merged into the new authority. The main motive for the merger was to strengthen and reinforce the supervision of both nuclear and non-nuclear activities, relating to nuclear safety and radiation protection, but also a general ambition by the Government to make civil service more efficient by reducing the number of administrative authorities.

SSM is the administrative authority for protection of people and the environment against harmful effects of ionising and non-ionising radiation, for issues on nuclear safety including physical protection in nuclear technology activities as well as in other activities involving radiation, and for issues regarding non-proliferation.

SSM shall actively and preventively work for high levels of nuclear safety and radiation protection in the society and through its activities act to:

1. prevent radiological accidents and ensure safe operations and safe waste management at the nuclear facilities,
2. minimize risks and optimise the effects of radiation in medical applications,
3. minimize radiation risks in the use of products and services, or which arise as a by-product in the use of products and services,
4. minimize the risks with exposure to naturally occurring radiation, and
5. contribute to an enhanced level of nuclear safety and radiation protection, internationally.

SSM shall ensure that regulations and work routines are cost-effective and uncomplicated for citizens and enterprises to apply/understand. SSM shall handle financial issues connected with the management of radioactive wastes from nuclear activities. The Authority shall inform the Nuclear Waste Fund about the size of payments and disbursements from the fund, planned or forecasted, by each reactor operator or other relevant licensee, and of the SSM's own activities regarding financing issues, so that the Nuclear Waste Fund can fulfil its tasks. SSM is in charge of the Swedish metrology institute for ionising radiation. The

SSM shall operate a national dose register and, as appropriate, issue national individual dose passports. The SSM shall furthermore:

- carry out Swedish obligations according to conventions, EU-ordinances/directives, and other binding agreements (e.g. contact point, report drafting, and to be the national competent authority);
- supervise that nuclear material and equipment is used as declared and in agreement with international commitments;
- carry out international cooperation work with national and multinational organisations;
- follow and contribute to the progress of international standards and recommendations;
- coordinate activities needed to prevent, identify and detect nuclear or radiological events. The SSM shall organise and lead the national organisation for expert advice to authorities involved in, or leading, rescue operations;
- contribute to the national competence development within the authority's field of activities;
- provide data for radiation protection assessments and maintain the competence to predict and manage evolving issues; and
- ensure public insight into all the authority's activities.

Other authorities with supervisory responsibility for the Swedish nuclear power plants

Other authorities with supervisory responsibility for the nuclear power plants are the Swedish Civil Contingencies Agency (MSB), the Swedish Work Environment Authority (AV), and the National Electrical Safety Board.

The Swedish Civil Contingencies Agency (MSB) was established 1 January 2009 and replaced the Swedish Rescue Services Agency (SRSA), the Swedish Emergency Management Agency (SEMA) and the Swedish National Board of Psychological Defence. The mission and tasks of MSB is to enhance and support societal capacities for preparedness for and prevention of emergencies and crises. MSB supervise and regulates the following: civil protection, flammables and explosives, transport of dangerous goods, preventing and limit the consequences of major chemical accidents, municipal and county council measures prior to and during extraordinary events in peacetime and during periods of heightened alert,

emergency management and heightened alert ordinance, shelters, total defence service, and public order.

The Swedish Work Environment Authority (AV) supervisory responsibility to ensure that the regulations regarding work environment and work hours are followed and to some extent that the tobacco act and the environmental code with regard to issues of genetic engineering and pesticides are followed. The mission and task of AV is to reduce the risks of illness and accidents at work and improving the work environment from a holistic perspective, that is, both in terms of physical, mental and social and work-organizational perspective.

The Swedish National Electrical Safety Board is the supervisory authority for electrical safety and electromagnetic compatibility (EMC). The mission and task for the National Electrical Safety Board is to achieve safe and interference-free electricity, to ensure high level of electrical safety and to prevent interference between electrical equipment.

11-H Regulation

The Basic Nuclear Safety and Radiation Protection Legislation

The following five acts constitute the basic nuclear safety and radiation protection legislation of Sweden:

- The Nuclear Activities Act (SFS 1984:3),
- The Radiation Protection Act (SFS 1988:220),
- The Environmental Code (SFS 1998:808),
- The Act on the Financing of Management of Residual Products from Nuclear Activities (SFS 2006:647), and
- The Nuclear Liability Act (SFS 1968:45).

With the exception of the Nuclear Liability Act, all acts are supplemented by a number of ordinances and other secondary legislation which contain more detailed provisions for particular aspects of the regime.

Operation of a nuclear facility can only be conducted in accordance with a licence issued under the Nuclear Activities Act as well as with a licence issued under the Environmental Code. The Nuclear Activities Act is mainly concerned with issues of safety and security, while the Environmental Code regulates general aspects of

the environment and the possible impacts of “environmentally hazardous activities”, to which nuclear activities are defined to belong.

A Committee of Inquiry to examine a potential merging of the provisions of the Act on Nuclear Activities and the radiation Protection Act (1988:220) was appointed by the Swedish Government in December 2008. The final report was submitted to the Government (SOU 2011:88) in March 2011 and the report suggests harmonization with the provisions of the Environmental code. The report is presently subject to referral consultation with the SSM and other relevant stakeholders. Potential changes of the legal framework, in response to the Committee's proposals, can at the earliest be decided 2013/2014.

The objective of the Radiation Protection Act is to protect people, animals and the environment from the harmful effects of radiation. The Act applies to radiation protection in general and, in this context, it provides provisions regarding worker’s protection, radioactive waste management, and the protection of the general public and the environment.

The Act on the Financing of Management of Residual Products from Nuclear Activities contains provisions concerning the future costs of spent fuel disposal, decommissioning of reactors and research in the field of nuclear waste. Means for that purpose have to be available when needed.

The Nuclear Liability Act implements Sweden’s obligations as a party to the 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy and the 1963 Brussels Convention Supplementary to the Paris Convention.

Other relevant acts are the Act on Control of Export of Dual-use Products and Technical Assistance (SFS 2000:1064) and the Act on Inspections according to International Agreements on Non-proliferation of Nuclear Weapons (SFS 2000:140). Emergency preparedness matters are regulated by the Civil Protection Act (2003:778) and Ordinance (2003:789).

On 18 December 1997 the Swedish Parliament adopted the Act on the Phasing-Out of Nuclear Power (SFS 1997:1320), which entered into force on 1 January 1998. The Act was part of the inter-party agreement on guidelines for energy policy, which was initiated by the Swedish Government in 1995 to create

conditions for the efficient use and cost effective supply of energy. Based upon provisions in this Act, the two boiling water reactors at Barsebäck were shut-down in 1999 and 2005, respectively. On 1 January 2011 the previous ban on constructing new reactors was removed through amendments to the Act (1984:3) on Nuclear Activities and the Environmental Code. The ten (10) current reactors in Sweden may be replaced with new, provided that they are erected on the same site as the existing.

Nuclear Safety and Radiation Protection Regulations

With reference to its legal mandate, the Swedish Radiation Safety Authority (SSM), issues legally binding safety and radiation protection regulations for nuclear facilities in its Code of Statutes SSMFS. SSM has reissued all earlier regulations by the SKI and SSI in the SSMFS series. In the following, regulations with relevance to the safety and radiation protection at nuclear installations, as defined by the Convention, are addressed.

In addition, general advice on the interpretation of most of the safety regulations is issued. The general advice is not legally binding per se, but cannot be ignored by the licensee without risking sanctions by the regulatory body. Measures should be taken according to the general advice or, alternatively, methods justified to be equal from the safety point of view should be implemented. The regulations and the general advice, listed below, all entered into force on February 1, 2009.

SSM's regulations also implement binding EU legislation and international obligations. In preparing SSM's regulations, IAEA safety standards, international recommendations, industrial standards and norms, and the rule-making of other Swedish authorities are considered. The SSM regulations are issued according to an established management procedure which stipulates technical and legal reviews of the draft. In accordance with governmental rules, a review of the final draft by authorities, licensees, various stakeholders, and industrial and environmental organizations is performed.

The SSM nuclear safety and radiation protection regulatory code includes:

- Regulations concerning safety in nuclear facilities (SSMFS 2008:1)

These regulations were developed for nuclear power reactors but are applicable, in a graded way, on all licensed nuclear facilities. Minor amendments regarding the requirements on safety program, safety analysis, safety analysis reports and technical specifications were made in the SSM regulations. The regulations aim at

specifying measures needed for preventing and mitigating radiological accidents, preventing illegal handling of nuclear material and nuclear waste and for conducting an efficient supervision, programmes for maintenance, continuous surveillance, inspections and testing as well as for the management of ageing degradation and damage:

- Application of multiple barriers and defence-in-depth
- Handling of detected deficiencies in barriers and the defence-in-depth
- Organisation, management and control of safety significant activities
- Actions and resources for maintaining and development of safety
- Physical protection and emergency preparedness
- Basic design principles
- Assessment, review and reporting of safety
- Operations of the facility
- On-site management of nuclear materials and waste
- Reporting to SSM of deficiencies, incidents and accidents
- Documentation and archiving of safety documentation
- Final closure and decommissioning

General advice on the interpretation of most of the requirements is given.

- The Swedish Radiation Safety Authority's General Recommendations concerning Section 5 of the Nuclear Activities Act (1984:3) (SSMFS 2008:6)

The SSM has issued general advice on the interpretation of the 5 § in the Nuclear Activities Act regarding the use of contractors. Contractors are defined as every physical or legal person to whom the licensee hands over an activity (provides a contracted service). This means that companies belonging to the same corporation as the licensee as well as staffing agencies are regarded as contractors. If a contractor is approved by the SSM and a permit is issued, although the overall responsibility for safety rests with the licensee, a contractor has legal duties and obligations for the nuclear activities defined by the contract and permit. SSM can decide on safety conditions for the contract. A contractor cannot, without

additional permit, use a subcontractor for activities within the contract. In no case is it allowed for a subcontractor to use a sub-subcontractor (fourth person).

- The Swedish Radiation Safety Authority's Regulations concerning Exemptions from the Requirement for Approval of Contractors (SSMFS 2008:7)

The Nuclear Activities Act (SFS 1984:3) provides rules regarding the allowed use of contractors. In general, a licensee cannot contract out an activity included in the nuclear licence without a permit by the Government or the SSM. However, if the licensee controls and follows up on the contractor's work, for certain activities the permit procedure can be replaced by a notification to the regulatory body. SSM is authorized by the Government to specify the prerequisites for such exemptions.

- The Swedish Radiation Safety Authority's Regulations on the Control of High-Activity Sealed Radioactive Sources (SSMFS 2008:9)

These regulations contain requirements stipulate that high activity sources for which no further use is foreseen must be sent either to the supplier, to the manufacturer or to an approved facility for waste management within six months. The holder must notify the SSM which keeps a register.

- Regulations on the Import and Export as well as Reporting of Radioactive Substances (SSMFS 2008:10)

These regulations stipulate that to import or export disused sealed sources a license is needed and the import/export must be reported to the competent authorities.

- Regulations on Physical Protection of Nuclear Facilities (SSMFS 2008:12)

These regulations contain requirements on organisation of physical protection, clearance of staff, tasks for the security staff, central alarm station, perimeter protection, protection of buildings, protection of compartments vital for safety, access control for persons and vehicles, protection of control rooms, communication equipment, search for illegal items, handling of information about the physical protection and IT-security. Design details about the physical protection shall be reported in a secret attachment to the SAR of the facility.

- Regulations concerning mechanical components in certain nuclear facilities (SSMFS 2008:13)

These regulations contain requirements for the design, manufacturing, installation, commissioning and use of pressurized and other mechanical components in nuclear facilities. The regulations also contain requirements for in-service

inspection and testing as well as the use of independent accredited inspection and testing bodies.

- The Swedish Radiation Safety Authority's Regulations concerning Emergency Preparedness at Certain Nuclear Facilities (SSMFS 2008:15)

These regulations on emergency planning and preparedness have a radiation protection perspective. They are mainly based on the IAEA Safety Standards GS-R-2: Preparedness and Response for a Nuclear or Radiological Emergency and include requirements on:

  - Emergency planning including alarm criteria and alarming
  - Emergency rooms/premises/facilities and assembly places
  - Training and exercises
  - Iodine prophylaxis
  - Personal protective equipment
  - Evacuation plan
  - Contacts with SSM
  - Radiation monitoring
  - Emergency ventilation
  - Collection of meteorological data

Depending on which category a facility belongs to (categories I, II or III depending on the radiological hazard potential at the facility), the requirements regarding radiation monitoring, emergency ventilation, and collection of meteorological data differ.

- Regulations on design and construction of nuclear power reactors (SSMFS 2008:17)

These regulations contain specific requirements for nuclear power reactors on design principles and the implementation of the defence-in-depth concept, withstanding of failures and other internal and external events, withstanding of environmental conditions, requirements on the main and the emergency control room, safety classification, event classification, requirements on the design and operation of the reactor core.

- Regulations and General Advice on the handling of Ashes Contaminated by Caesium-137 (SSMFS 2008:16)

These regulations are applicable for the production of energy by forest bio fuels in incineration facilities that produce a yearly volume of 30 tons of ashes or more. The regulations contain precautionary provisions regarding the handling of ashes for different options, such as returning the ashes to the forests for nutrition, spreading the ashes on agricultural and grazing lands for nutrition, reusing the ashes as road- or landfill and for the design of the waste disposal site if the ashes are deposited.

- The Swedish Radiation Safety Authority's Regulations on Planning before and during Decommissioning of Nuclear Facilities (SSMFS 2008:19)

These regulations comprise requirements for decommissioning with respect to documentation, alternative actions and waste management with regards to radiation protection.

- The Swedish Radiation Safety Authority's regulations concerning safety in connection with the disposal of nuclear material and nuclear waste (SSMFS 2008:21)

These regulations contain requirements concerning the long-term safety of a disposal facility. These regulations stipulates that for repositories, the safety assessments shall also comprise features, events and processes that can lead to the dispersion of radioactive substances after closure. Such safety analyses shall be made before the commencement of disposal facility construction, operation and closure.

- Regulations on Handling of Radioactive Waste and Nuclear Waste at Nuclear Facilities (SSMFS 2008:22)

These regulations contain provisions on predisposal management, e.g. on planning and quality assurance of radioactive waste management, on documentation and registration of radioactive wastes, and also for reporting to the SSM.

- The Swedish Radiation Safety Authority's Regulations on Protection of Human Health and the Environment in connection with Discharges of Radioactive Substances from certain Nuclear Facilities (SSMFS 2008:23)

These regulations contain provisions for releases of radioactive substances from nuclear facilities during normal operation, based on optimization of radiation protection and shall be achieved by using the best available technique (BAT). The optimization of radiation protection shall include all facilities located within the same geographically delimited area. The effective dose to an individual in the critical group of one year of releases of radioactive substances to air and water from all facilities located in the same geographically delimited area shall not exceed 0.1 mSv.

- The Swedish Radiation Safety Authority's Regulations on Radiation Protection Managers at Nuclear Facilities (SSMFS 2008:24)

According to these regulations a licence holder shall appoint a radiation protection manager at the facility in order to implement and look after radiation protection conditions issued by the authorities.

- The Swedish Radiation Safety Authority's Regulations on Radiation Protection of Individuals Exposed to Ionizing Radiation at Nuclear Facilities (SSMFS 2008:26)

These regulations contain provisions on limitation of exposures as far as reasonably achievable, social and economic factors taken into account. For this purpose the licence-holder shall ensure that goals and needed actions for control are established and documented and that needed resources are available.

- Regulations on Accelerators and Sealed Sources (SSMFS 2008:27)

These regulations stipulate that the license-holder shall ensure that an up-to-date and documented plan exists for decommissioning the plant. The plan shall include an analysis of the resources needed to take care of all radioactive substances and radioactive demolition waste in a safe way from a radiation protection point of view.

- The Swedish Radiation Safety Authority's General Recommendations on the Competence of Radiation Protection Experts (SSMFS 2008:29)

- The Swedish Radiation Safety Authority's Regulations concerning the Competence of Operations Personnel at Reactor Facilities (SSMFS 2008:32)

These regulations include requirements on competence analysis, competence assessment, authorization by the licensee, recruitment and training for a position, and retraining of operations personnel belonging to the categories operations management, control room personnel and field operators. If an individual satisfies all requirements regarding competence and suitability, the licensee may issue an authorization valid for three years. Every year, an intermediate follow up shall be done in order to check that the essential competence is maintained. The regulations require the use of full scale simulators for operational training.

- Regulations on Radiation Therapy (SSMFS 2008:33)

These regulations stipulate that in the case of the purchase of radioactive sources or equipment, which contains such sources, a plan shall be drawn up for the future handling of radioactive waste.

- Regulations on the Protection of Human Health and the Environment in connection with the Final Management of Spent Nuclear Fuel and Nuclear Waste (SSMFS 2008:37)

These regulations apply to disposal of spent nuclear fuel and nuclear waste. They are not applicable for low-level nuclear waste landfills. The basic requirement is that human health and the environment shall be protected from detrimental effects of ionising radiation, during operation as well as after closure. Another important requirement is that impacts on human health and the environment outside Sweden's borders may not be more severe than those accepted in Sweden. The regulations contain provisions on e.g. BAT and optimization, risk criterion and most exposed group, time periods for the risk analysis and, compliance demonstration for different time periods.

- Regulations on Filing at Nuclear Plants (SSMFS 2008:38)

These regulations apply to the filing of documentation that is drawn up or received in connection with the operation of nuclear plants. Certain documentation has to be filed. If the practice ceases, the archives shall be transferred to the National Archives of Sweden.

- The Swedish Radiation Safety Authority's Regulations on the Discharging of Goods and Oil from Controlled Areas at Nuclear Facilities (SSMFS 2008:39)

These regulations contain provisions for clearance of contaminated goods and oil for unrestricted use or for disposal as conventional non-radioactive waste.

- Regulations on the Use of Equipment in Industry Containing Sealed Sources or X-Ray Tubes (SSMFS 2008:40)

These regulations stipulate that equipment containing a radioactive source for which no further use is foreseen, shall be sent to a radioactive waste management facility within six months.

- Regulations on Smoke Detectors for Domestic Use Containing Radioactive Sources (SSMFS 2008:47)

These regulations stipulate that the units are collected and sent for dismantling.

- Regulations on Smoke Detectors for Industrial Use Containing Radioactive Sources (SSMFS 2008:44)

These regulations stipulate that the disused units should be taken care of as radioactive waste and returned to the supplier or manufacturer.

- The Swedish Radiation Safety Authority's regulations concerning basic provisions for the protection of workers and the general public in practices involving ionising radiation (SSMFS 2008:51)

These regulations are general and apply to the exposure of workers and the public in both planned and emergency exposure situations. They are based on European provisions in the EU BSS[29]. They contain fundamental requirements on the licensee/operator for justification of the activities, optimisation of the radiation protection and limitation of individual doses (dose limits). They address the categorisation of workers and work places; stipulate Swedish dose limits for workers (including apprentices) and the public, and address the required information and protection of pregnant or breast-feeding women.

Modernisation and safety improvement programmes for Swedish nuclear power plants

1 January 2005 regulations on design and construction of nuclear power reactors, now SSMFS 2008:17 and general advice on their interpretations came into force with transitional provisions. These regulations includes requirements regarding improvement and implementation of design principles for defence in depth, physical and functional separation, diversification of safety functions, accident management measures, withstanding local dynamic effects from pipe breaks, resilience to failures and other internal and external events, operational aids, environmental tolerance and environmental impact, provisions concerning control rooms, safety classification, provisions concerning the reactor core. The regulations are based on Swedish and international operating experience, recent safety analyses, results from research and development projects and the development of IAEA safety standards and industrial standards that were applied in the construction of the facilities. However, the new regulations do not cover all aspects of a design standard but those issues which are considered important to regulate for the Swedish reactors.

Since the 10 operating power reactors in Sweden have different prerequisites to comply with general regulations on design and construction, an assessment of the consequences was made for each reactor. This assessment included whether further analyses and back fitting were needed in relation to each paragraph of the regulations. A cost estimate was made for each measure and summarized for the specific reactor. The work will be conducted over a relatively concentrated period of time, up to year 2015.

29 Council Directive 96/29/Euratom of 13 May 1996, laying down basic safety standards for the health protection of the general public and workers against the dangers of ionising radiation [O. J. L-159 of 29.06.1996].

The total cost for the upgrading programme has been estimated at about 8 billion SEK (800 million Euros). The heaviest costs are associated with measures to improve the physical and functional separation, diversification measures, and upgrading the emergency control posts.

In addition to the plant modifications, the licensees also need to implement measures to comply with SSM's new regulations concerning physical protection (SSMFS 2008:12) and safety in nuclear facilities (SSMFS 2008:1). The later includes requirements regarding programmes for maintenance, continuous surveillance, inspections and testing as well as for the management of ageing degradation and damage.

Lifetime extension

The licenses for existing nuclear reactors are not limited in time. They may be operated as long as all safety, security, radiation protection and environmental requirements are fulfilled. The licensees have plans to operate the existing plants 50-60 years. SSM will therefore examine the question of continued operation beyond the original designed and analysed in time under the Periodic Safety Review (PSR) for each plant. The requirements for PSR has therefore recently been extended and incorporated in the nuclear activity act.

The Swedish Radiation Safety Authority is currently (March 2012) conducting investigations and preparing reports for the Swedish government in the area of long-time operation and life extension. These reports will include the regulatory view on the need for any further requirements or updates to existing regulations.

Expected changes in nuclear regulations following the accident at Fukushima Dai-ichi NPP

The Swedish Radiation Safety Authority is currently (March 2012) conducting investigations and preparing reports for the Swedish government in the area of long-time operation, which also includes the authority evaluations and conclusions of the lesson learned from the accident at Fukuchima Dai-ichi NPP. Thus, the reports will include the regulatory view on the need for any further requirements or updates to existing regulations as a result of the lessons learned from the accident at Fukushima Dai-ichi NPP.

11-I Public Awareness

It is considered very important to give the general public insights and information on nuclear activities carried out within the country and in the local area, as well as outside the Swedish border. In municipalities where major nuclear facilities are located (power reactors, research reactors, and facilities for manufacturing, handling, storage or disposal of nuclear material or nuclear waste) it is particularly important that the residents are given correct and reliable information. For this purpose local safety boards have been established in the municipalities of Kävlinge (Barsebäck NPP), Oskarshamn (Oskarshamn NPP), Nyköping (Studsvik research facility), Varberg (Ringhals NPP) and Östhammar (Forsmark NPP).

The licence-holder for a major nuclear facility is required to give the local safety board insight into the safety and radiation protection work at the facility. The licence-holder shall, at the request of the local safety board:

- give the board information of the facts available and allow the board to study relevant documents; and
- give the board access to plants and sites.

The purpose of the local safety board is to obtain insight of safety and radiation protection matters and to inform the public about these matters. It is not within the local safety board mandate to impose requirements on or to prescribe safety-enhancing or other measures for nuclear facilities. These obligations rest exclusively within the regulatory authorities.

The Swedish Radiation Safety Authority is responsible of informing the society about radiation protection issues both within Sweden and outside of the Swedish border. This responsibility is carried out through a number of activities. For example, an education centre was established in 2004, which teaches courses in the area of radiation protection. Also, the regulatory authority issues periodic reports to inform the public of major activities, as well as issuing reports where R&D results and important regulatory assessments are published. All reports published by the regulatory authority are open to the media and the public.

Furthermore, the requirements for the Swedish authorities include regulations regarding openness and provision of information services to the public, politicians and media are very high. Swedish official documents are public unless a decision is made to classify them according to the Public Access to Information and Secrecy Act (SFS 2009:400). The reasons for secrecy could be those of national security, international relations, commercial relations, or the individual right to privacy. A person that would want to access information does not need to justify

this wish to see any public documents; neither does this person need to reveal her/his identity to have access to the documents.

Appendix 1

Management and disposal of spent nuclear fuel and radioactive waste

TYPE OF LIABILITY	LONG-TERM MANAGEMENT POLICY	FUNDING OF LIABILITIES	CURRENT PRACTICE /FACILITIES	PLANNED FACILITIES
SPENT FUEL	NPP licensees jointly responsible. Strategy in place for disposal	Funded by fees on production of nuclear energy collected in segregated funds (Nuclear Waste Fund)	Stored on site initially, then transferred to central interim storage facility (Clab)	Licence application for spent fuel disposal facility under review
NUCLEAR FUEL CYCLE WASTES	NPP licensees jointly responsible. Strategy in place for disposal	Funded by fees on production of nuclear energy collected in Nuclear Waste Fund Disposal of short-lived operational LILW waste (SFR) from NPPs paid for directly by owners	Short-lived LILW disposal at existing repository (SFR); Shallow land burial sites for VLLW short-lived waste exist at NPP sites	Preliminary plans for disposal facility for long-lived LILW (SFL). License application expected 2030

NON-POWER WASTES	Strategy in place for disposal – Further actions on-going	Funded by producers/ owners of waste Government funding available for legacy wastes	Short-lived LILW disposal at existing facilities for nuclear fuel cycle waste (SFR) when appropriate; Long-lived LILW to be interim storage pending disposal in facility for long-lived LILW nuclear fuel cycle waste (SFL)	To be disposed of in planned disposal facility for long-lived LILW nuclear fuel cycle waste (SFL)
DECOMMIS-SIONING LIABILITIES	Licensee is responsible	Funded by producers/owners of waste	Preliminary plans for decommissioning exist; Reviews of the adequacy of funding on-going	Short-lived LILW to be disposed of in extension to existing SFR facility License application for extension expected in 2013 Long-lived LILW to be disposed of in planned disposal facility for long-lived LILW nuclear fuel cycle waste (SFL)

DISUSED SEALED SOURCES	Returned to manufacturer	Funded by producers/ owners of waste Government funding available for orphan sources	Returned to manufacturer, disposed of in SFR, or in interim storage pending disposal in facility for long-lived LILW nuclear fuel cycle waste (SFL)	To be disposed of in disposal facilities for nuclear fuel cycle wastes (SFR, SFL) as appropriate

Table 20: Overview of the Swedish program for management and disposal of spent nuclear fuel and radioactive waste.

Appendix 1

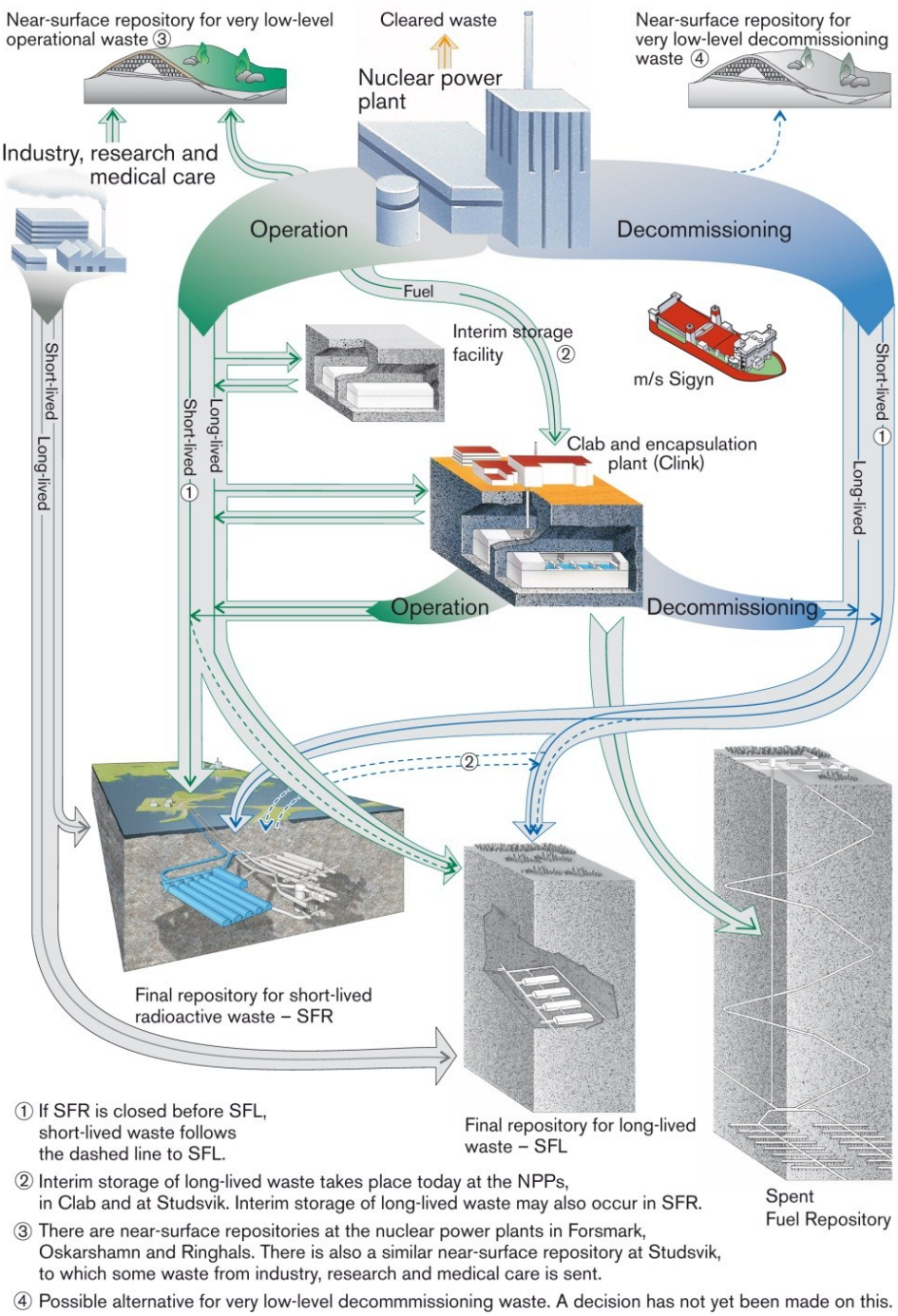


Figure 20: Management system for spent fuel and nuclear waste as presented in RD&D-program 2010.

Appendix 2

1. Nuclear waste - repositories and storages

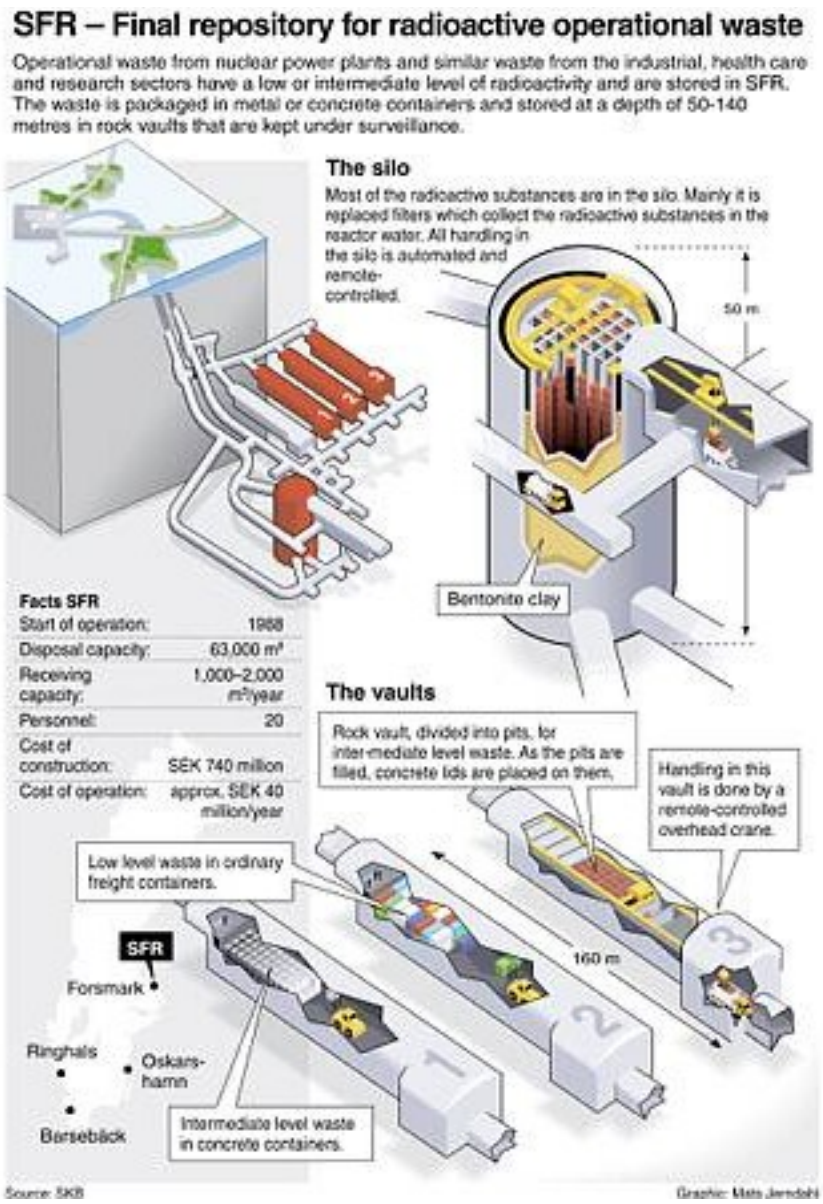


Figure 21: The SFR facility

Appendix 2

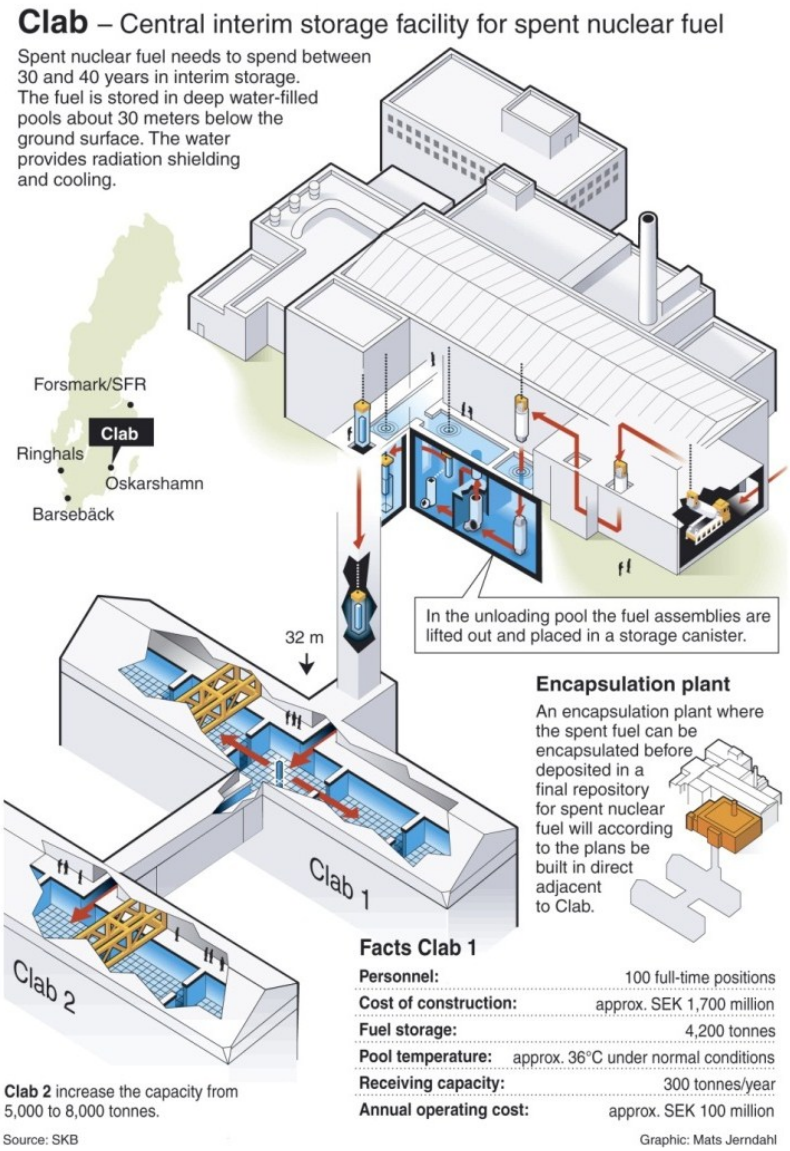


Figure 22: The Clab facility.

Appendix 2

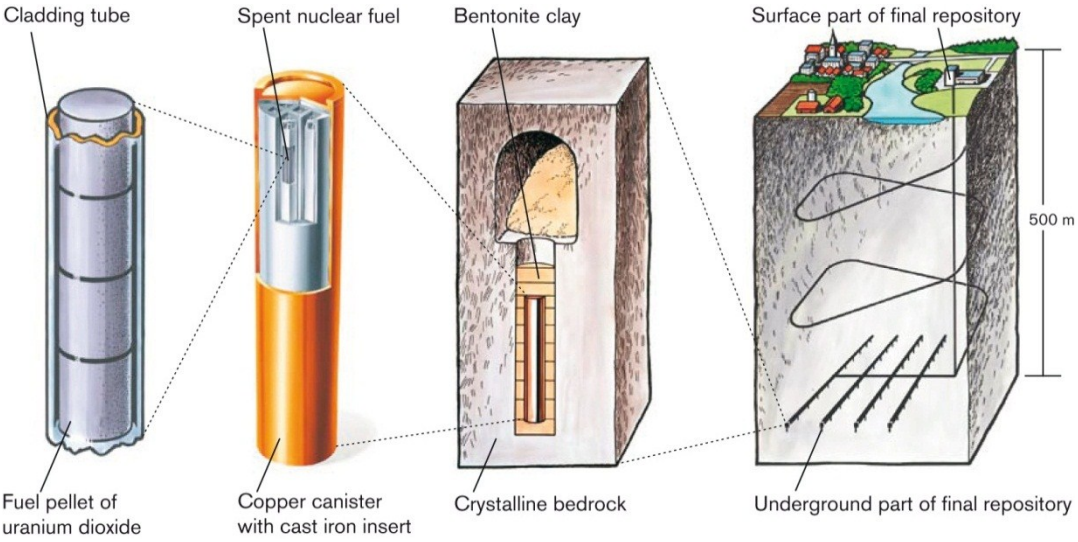


Figure 23: The reference method for disposal of spent nuclear fuel.

12. Energy Technology Research, Development and Innovation (ETRDI)

12-A Policies overview including major changes since previous IDR

During the 1980s, growing pressure for phasing out nuclear power production provided a strong driving force behind energy research. Attention was also paid to the environmental problems associated with the production and use of energy. Depletion of the ozone layer and effects on the climate are examples of global environmental problems that have strongly influenced the direction of energy related research.

Based on a new governmental bill on Energy Research and Development Towards Future Energy Systems (Prop. 2005/06:127)[30] Parliament in June 2006 decided on a policy for energy research, development and demonstration (RD&D). The bill gave directives on the continuation of the long-term goals for energy RD&D which is still today valid. In addition to building scientific knowledge an increased focus on commercialisation of results and priority settings was proposed. The Bill of 2006 also gave direction on visions, goals and priorities for six thematic areas. The Energy RD&D programme shall focus on the needs of the users, deployment of R&D results, commercialisation of technologies and services, build-up of scientific and technological knowledge and competence and further increase the collaboration with different stakeholders, both nationally and internationally.

The national Energy Research Programme run by the Swedish Energy Agency is based on the above mentioned bill, but has over the years evolved and changed. Today, the programme is concentrated on fewer thematic areas than before, although the main driving forces are similar: reduction of carbon dioxide emissions and reduced dependence on fossil fuels. There are clear requirements for the results of research to be implemented in industry and society as a whole. Work should also be concentrated on areas in which Sweden has the greatest strength and potential for results. Greater emphasis is therefore given to cooperation with industry and other intended users of the results. The national Energy Research Programme assists the creation of competence and knowledge of the energy system through support for research at university level, by other

[30] Forskning och ny teknik för framtidens energisystem, Prop. 2005/06:127, http://www.regeringen.se/content/1/c6/06/06/68/5d252c05.pdf

research institutes and in the private sector. It supports the development of new technologies, their commercialisation and market introduction. Research is also intended to reduce the costs of new energy technology and system solutions in the field of renewable energy and energy efficiency. Energy research is also intended to benefit industry as a whole by creating stable conditions for a competitive industry, assisting renewal and development of Swedish industry. Lead times between research and implementation are long. Results being implemented today typically stem from work that was started ten or twenty years ago. To meet the challenges of the future, energy research requires a long term approach, an overall view and patience. The overall aim is that, over the next 10-15 years, Sweden should greatly increase the proportions of its heat and electricity production from renewable energy sources, and that commercially viable means of improving the efficiency of energy use should be developed. The current Energy Research Programme has no fixed end date and will normally be evaluated every fourth year.

Although energy research, development and demonstration (RD&D) activities are necessary for a transition to a sustainable energy system, they are not enough on their own. Synergies with other policy measures and instruments, such as legislation, taxation, standardisation, grants and other financial incentives, as well as information to consumers and producers, are essential in order to reach the objectives. An example of one such instrument is the taxation of carbon dioxide emissions, which is intended to discourage the use of oil for heating purposes. Another example is the electricity certificate system, which supports increased production of electricity from renewable energy sources, such as bioenergy, wind power, hydro power and peat. Another important policy measure is that of technology procurement, which stimulates and accelerates the development and introduction of new technologies. Technology procurement of new products, systems or processes is intended to meet purchasers' needs better than existing products on the market.

Through the creation of new knowledge, development of new technology, emphasis on the utilisation of R&D results in practical applications in industry and society as a whole energy research contributes to achieving the targets set in the energy and climate policy decided on by Parliament in 2009 (see chapter 1-A).

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12-B Previous IDR recommendations

The government of Sweden should:

- *Consider establishing quantitative targets for energy R&D to support its consistency with the general energy policy goals.*

The choice has been made to give the Swedish Energy Agency the task of formulating quantitative and qualitative visions, goals and targets for the thematic areas, and for any subdivisions of these, in consultation with industry, researchers and society. This places the strategic processes closer to the stakeholders and makes for more flexible and well-informed priority setting.

- *Continue to emphasise commercialisation of near-market technologies by, for example, considering and fine-tuning policies and measures to stimulate demand.*

The commercialisation is again stressed in the evaluation of the programme from 2010. Efforts to stimulate the demand for different types of energy solutions have also been introduced (i.e. for photovoltaics, biogas, wind, etc.)

- *Continue to actively participate in international collaboration.*

Sweden has since the previous In Depth Review continued to participate in IEA Implementing Agreements, and has also joined new collaborations like the Clean Energy Ministerial, the IRENA, and the Global Carbon Capture and Storage Institute (GCCSI).

12-C ETRDI priorities

The Swedish Energy Research Bill of 2006 gives direction on visions, goals and priorities for six thematic areas. The Energy RD&D programme shall focus on the needs of the users, deployment of R&D results, commercialisation of technologies and services, building up scientific and technological knowledge and competence and further increase the collaboration with different stakeholders, both nationally and internationally.

The national Energy Research Programme which is run by the Swedish Energy Agency is based on the above mentioned Bill has six prioritised thematic areas in focus:

- Energy System Studies,
- The Building as an Energy System,
- The Transport sector,
- Energy-intensive Industry,

- Biomass in Energy Systems and
- The Power System.

Within each of these areas, research is organised mostly into specific programmes, the number of which can vary with time, depending upon identified research needs.

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12-D Division of responsibilities and decision making process

The Swedish Energy Agency has the overall responsibility for implementation of energy RD&D policy and the national Energy Research Programme. Some energy related activities are also carried out by other agencies in cooperation with the Swedish Energy Agency. Basic research on nuclear fission and fusion is financed by VR, the Swedish Research Council. More general basic research in the energy field is carried out jointly between the Swedish Research Council (evaluating scientific quality) and the Swedish Energy Agency (evaluating relevance).

The Energy R&D Board of the Swedish Energy Agency is the ultimate decision making authority for the Energy Research Programme. Its members are appointed by the Government and represent different areas of experience and competence. The members are drawn from universities, industry and the public sphere. Normally the Board itself decides on larger programme commitments and larger individual projects.

In 2011, about 50 programmes under the six thematic areas were active, in addition to a large number of individual projects. Working in thematic areas facilitates coordination and information exchange between different technology areas. Any synergy effects or overlaps between different theme areas are handled and further investigated or monitored as part of the work of the Energy Systems Studies working area. Sectorial advisory boards and technology platforms have been established for each of the six thematic areas, bringing together experts from industry, public authorities and other stakeholders, to support the Swedish Energy Agency in developing strategic research plans for each thematic area. The advisory boards and technology platforms also assist the Swedish Energy Agency in identifying and analysing the needs of different players that are energy users, and in identifying obstacles that could prevent the energy system from operating effectively.

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12-E Funding

Figure 24: Sweden. Government Energy RD&D Budget (M SEK)

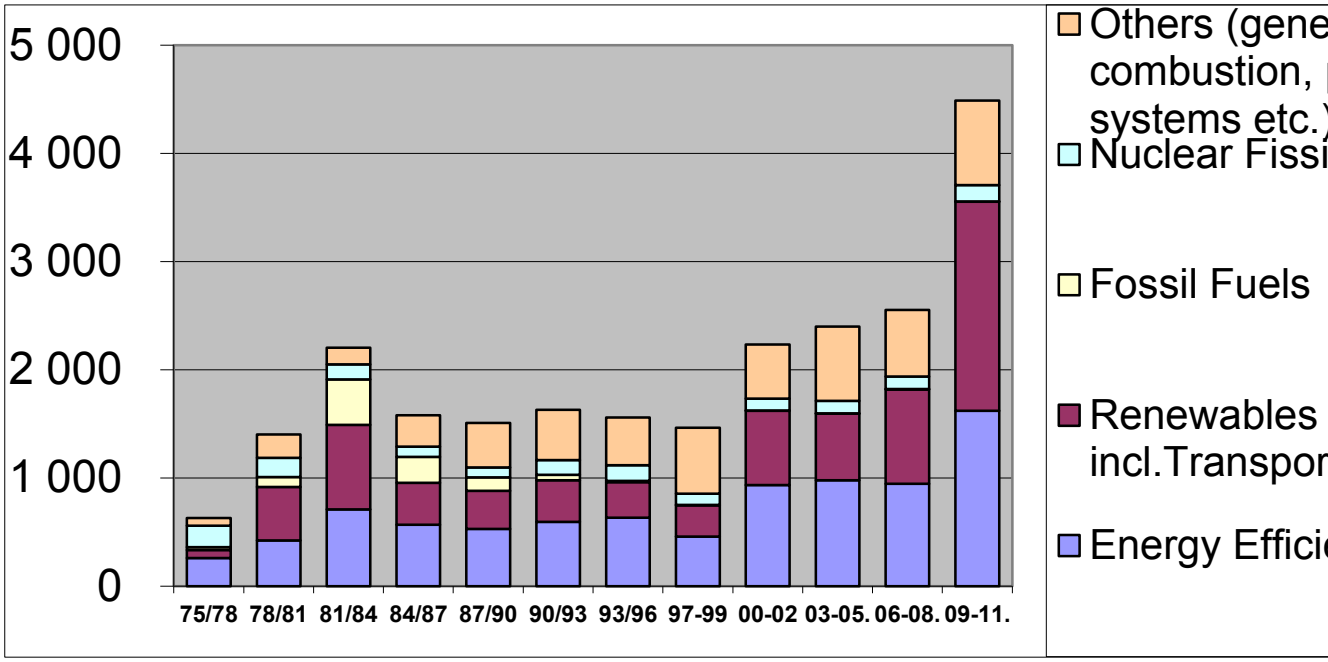

Table 21: Sweden. Information on Government Energy RD&D Budgets (M SEK)

Technology areas	2003-05. Mkr	2006-08. Mkr	2009-11. Mkr	**1975-11. Mkr**	2011 Outcome Mkr	2003-05. Procent	2006-08. Procent	2009-11. Procent	**1975-2011.** Procent	**2011.** Procen
Energy use/Energy efficiency	**979**	**947**	**1 621**	**8 647**	**513**	**41%**	**37%**	**36%**	**37%**	**32%**
Industry	302	313	202	2 205	63	13%	12%	4%	9%	4%
Buildings	96	144	178	1 944	59	4%	6%	4%	8%	4%
Transport (excl. prod. fuel from 06)	516	427	1 169	3 661	367	22%	17%	26%	15%	23%
other (hp, DH excl. wastefrom 06)	65	64	73	837	23	3%	2%	2%	4%	1%
Fossil fuels	**3**	**2**	**3**	**972**	**2**	**0%**	**0%**	**0%**	**4%**	**0%**
Coal, gas , slate				433					2%	
peat	3	2	3	539	2	0%	0%	0%	2%	0%
Renewable energy sources	**616**	**871**	**1 931**	**7 204**	**759**	**26%**	**34%**	**43%**	**30%**	**48%**
solar (heat/PV/)	101	101	190	1 365	64	4%	4%	4%	6%	4%
Vind	88	69	152	1 030	62	4%	3%	3%	4%	4%
Biomass (incl. fuel from 2006)	358	631	1 382	4 299	553	15%	25%	31%	18%	35%
other (wave, hydrot, gethermal etc)	69	70	207	510	79	3%	3%	5%	2%	5%
Nuclear (fission)	**116**	**117**	**152**	**1 579**	**54**	**5%**	**5%**	**3%**	**7%**	**3%**
General	**685**	**615**	**779**	**5 238**	**259**	**29%**	**24%**	**17%**	**22%**	**16%**
System analysis	106	230	229	820	69	4%	9%	5%	3%	4%
other (el prod, gasification/use.)	580	385	550	4 417	191	24%	15%	12%	19%	12%
Total R,D&D current prices	**2 399**	**2 553**	**4 486**	**23 640**	**1 586**	**100%**	**100%**	**100%**	**100%**	**100**
Demonstration		**20%**	**32%**		**33%**	**2 399**	**2 553**	**4 486**	**23 640**	**1 5**

12-F Evaluation

In 2009, the Government commissioned an evaluation of the Energy Research Programme from the consulting firm Ramböll Management.

The results were presented and discussed in a hearing, and subsequently communicated to Parliament in the form of a Government Bill (skr. 2009/10:168 Utvärdering av insatserna för forskning och innovation inom energiområdet).

The evaluation was not as thorough as the previous study (SOU 2003:80) that formed the basis for the 2006 Bill on Research and New technology for the Energy System of the Future. It focused on the processes, strategies and priorities of the Energy Agency and the Energy Research Programme, and not so much on an evaluation of the results for the RD&D financed.

Overall, the Government found that the Energy Agency had responded to the guidelines and instructions of the Bill of 2006, and that the activities corresponded to the intentions.

Some signals on further development were given, like that the Energy Agency should

- Make increased efforts on communicating the results
- Continue the efforts to guarantee the quality of the funded activities
- Analyse new ways to increase commercialisation
- Ensure that the concensus sought in strategy and priority setting does not counteract new initiatives and effeorts
- Increase efforts to collaborate with other national, regional and local agencies and organisations.

12-G International collaborative efforts

For a small and R&D oriented country such as Sweden, international collaboration and monitoring of the business climate is essential as part of energy research policy and energy policy. The fora utilised are primarily the EU Seventh Framework Programme for Research and Technological Development (FP7), the International Energy Agency (IEA), the Nordic Energy Research Programme and bilateral agreements with a number of strategically selected countries.

European Union

EU membership increases the scope for international cooperation. Research in Europe is increasingly, carried out sharing the work between countries in joint projects. It is therefore important that Swedish research environments possess the skills and characteristics that make them interesting partners for international stakeholders. In some areas, it is more cost-effective to work with other countries than to establish national research. An essential aspect of EU membership is also that it gives access to an important market for Swedish exports, giving increased opportunities for commercialisation of research results.

New EU directives in the energy sector influence the research agenda and development activities to greater or lesser extents. Another international area that can influence research work is standardisation, where various elements of research may also be involved.

FP7, running from 2007-2013, is the EU's main instrument for funding research within the union. The Energy thematic area has a budget of about EUR 2 350 million. On assignment from the Government, an expert from the Swedish Energy Agency takes part in the work of the Programme Committee for the Energy thematic area. The Committee is chaired by the European Commission and discusses issues such as the objectives and content of the annual Work Programmes, which form the basis for calls for proposals. The Swedish Energy Agency may co-fund research projects in Sweden that receive financing from FP7.

FP7 has introduced a new concept - the EU –Technology Platforms. The purpose of these platforms is to bring together representatives of companies, research institutes, public authorities and consumers. Working in specific and carefully delineated technical development areas, the different parties are intended to develop common European visions of technical development and identify possible ways forward.

The European Research Area (ERA) was launched under the Sixth Framework Programme (FP6). The idea was to bring together the European Community's R&D resources in order to coordinate research and innovation activities at the level of both the member states and the European Union. The ERA-NET was created in order to facilitate coordination between member states. The objective is for research-funding bodies within the ERA to work together more closely and coordinate research and development efforts that would otherwise be carried out at a national level. Within each network (ERA-NET project), the intention is that countries involved should inform each other of their respective programmes and activities, as well as identify obstacles and opportunities for increasing coordination of research and development. Countries can also decide on common activities and develop a strategy for carrying them out, as well as investing in projects that involve several countries. The exchange of information within ERA-

NET is particularly valued by the partners involved in the work. The Swedish Energy Agency has been a member of five ERA-NET activities.

In 2007, the European Commission published its proposal ”**A European Strategic Energy Technology Plan (SET-Plan) – Towards a low-carbon future”**. One key element of the SET Plan involves setting out a long-term energy research, demonstration and innovation agenda for Europe, to guide the research and development of new energy technologies and promote their uptake by the market. The Plan also includes a governance structure and mechanisms to guide and track implementation of the Plan which is based on the Industrial Initiatives in each of the six prioritized research areas. A high-level European Community Steering Group for Strategic Energy Technologies has been created to coordinate and facilitate joint efforts. It is important for Swedish energy R&D to take account of the joint European efforts in the SET Plan. The work is essential in ensuring fulfilment of both EU and national targets for 2020 and 2050. Some of the Industrial Initiatives are highly relevant to important parts of Swedish industry. Thus Sweden has decided to actively join the following areas for research cooperation: Wind, Bioenergy, Smart grids and Smart Cities. The operation of these activities will start during 2012 and increasingly influence the Swedish research programme.

The International Energy Agency

The Swedish Energy Agency participates together with the Ministry of Enterprise, Energy and Communications in IEA’s higher management bodies, such as the Committee on Energy Research and Technology (CERT) and the Standing Group on Long-Term Co-operation (SLT). The IEA work also engages a large number of Swedish researchers and representatives from industry. Belonging to 23 Implementing agreements, Sweden is one of the countries participating in the largest number of Implementing agreements.

The Nordic Energy Research Programme

The Nordic countries have a similar approach to, and share, high ambitions regarding renewable energy and energy efficiency. A common Nordic Energy Research Programme has been running since 1985. At first, the focus was on researcher mobility between countries and grants to scientists enabling them to collaborate with other Nordic universities. Since 1999, **the Nordic Energy Research Programme** has been organised as a Nordic institution of its own under the Nordic Council of Ministers, with headquarters in Oslo. Overall strategy and detailed application plans are determined for a four-year period at a time. The research programme is strategically concentrated on a number of priority areas.

For the period, 2007 to 2010, funding was provided for research in the fields of integration of energy markets; renewable energy; more efficient use of energy; the hydrogen society and climate change resulting from activities associated with the energy sector.

The 7th edition of the main Nordic 4-year research programme is called Sustainable Energy Systems 2050, and constitutes the thematic focus for Nordic Energy Research during 2011-2014. The aim of the programme is to develop Nordic added value through knowledge and solutions for a future sustainable energy system.

With a budget of 100 MNOK over 4 years, the programme supports 10 unique and interdisciplinary projects within Renewables, Market & Grids and Low Carbon Transport. Each project includes researchers from at least three Nordic countries.

The idea of a **top-level research initiative** (TRI) within the sphere of overall Nordic cooperation was launched at the summer meeting of the Nordic Council of Ministers in Finland in 2007. The Nordic governments have agreed to invest 480 million SEK over the period 2009-2013 for research and development of new technology related to climate, the environment and energy. The initiative is not concentrated only on research into new technology or development thereof, but is also partly a research programme aimed at gaining a better understanding of climate and associated areas of relevance.

The energy related subprogrammes of the TRI are mainly **Integration of large-scale wind power**, and **Sustainable bio-fuels**, but also **Energy efficiency with nanotechnology** and **CO2 – capture and storage.**

Bilateral agreements

Sweden has bilateral agreements concerned specifically with energy and research with several countries: Brazil, India, China, and the USA, and one with the state of California.

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12-H Involvement of the Private sector

The private sector is involved in energy research, development and demonstration in many different ways. For example as members of the Energy R&D Board; taking part in advisory boards and through in kind participation in projects.

The Energy Research Programme as a whole is funded both by the Energy Agency and by industry. The ratio has been about 1:1 in the past. Currently, the

special initiative on large-scale demonstrations projects, for which the government made an extra 875 million SEK available, means that the contributions from industry has been higher the last three years.

Table 22: Financing of Energy RD&D 2009 – 2011 in million Swedish kronor

	2009		2010		2011	
	MSEK	%	MSEK	%	MSEK	%
Swedish Energy Agency	1 239	42 %	1 332	39 %	1 411	37 %
Industry and Industrial organisations	1 712	58 %	2 063	61 %	2 404	63 %
Total	2 951	100 %	3 395	100 %	3 815	100 %

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12-I Noteworthy projects and research areas

Long term energy research in the National Energy Research Programme is as described under chapter 12-A, divided into six thematic areas: Energy System Studies, the Building as an Energy System, the Transport sector, Energy-intensive Industry, Biomass in Energy Systems and the Power System.

Energy System Studies

The Energy Systems Studies thematic area includes not only system science research as often defined by scientists, but also investigations of the behaviour and actions of individuals or organisations, viewed from such perspectives as the national economy, legal aspects or sociology. The basis for this system perspective is that all technology can be seen as closely linked parts that create a whole. Technically, an energy system can be defined as consisting of a number of subsystems, either hardware-defined, such as a district heating plant and distribution system, or an electricity distribution network, or structure-defined, such as a utility owned by a local authority. But these technical systems are owned, controlled, developed, operated and used by many parties and organisations, all of whom affect the various systems and who can be regarded as connected with them. Energy systems and those involved in or with them are also affected by taxation, legislation, regulations and events in the wider world. Most of these factors also have reciprocal effects upon each other. It is therefore not sufficient to look for one answer to a question at a time, as this fails to consider the underlying understanding of the relationships within the whole. Bearing in mind the general principle that system research should focus on and facilitate

transformation of the energy system, the overall criteria for prioritising among the activities includes studies that:

- clarify relations between different sectors, and underpin dialogue and more desirable solutions (i.e. avoiding sub-optimisation),
- facilitate energy policy decisions and long-term consistency in energy policy,
- apply a long-term perspective (20–100years), and identify those measures and connections, obstacles and opportunities, that are most important for evolution of the energy system;
- employ a system approach to deliver broad knowledge of complex questions to various stakeholders. Add to this a general need to develop methods and theory of energy systems research.

A special activity funded by the agency is the **Energy Systems Programme** which trains scientists with a broad system view of energy matters. The Energy Systems Programme brings together five departments at four Swedish universities to train PhD students and develop knowledge about the energy system. The programme has two main elements: a long term research component, and a graduate school that trains groups of PhD students.

As the main financer, the Swedish Energy Agency has contributed to the establishment of climate policy research by a number of research groups at different Swedish universities. The research is divided into three areas:

- Strategic aspects concerning the Kyoto Protocol and post-Kyoto negotiations
- Climate policy instruments in the context of acceptance, technology diffusion and policy transfer
- The carbon market within the context of post-2012 negotiations

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In 2009, the Swedish Energy Agency started an R&D programme under the title of **Energy, IT and Design**. The main emphasis of the programme is to influence the everyday habits, values and behaviour of users as far as improving the efficiency of energy use is concerned, with some concentration on improving the efficiency of electricity use through application of both IT and design. It has been calculated that the potential for improvement in the efficiency of (in particular) electricity use in residential buildings in the order of 20–30%. The programme

entails a vision of a society in which citizens are aware of their daily energy use and can easily control it, whether at home, at work or while travelling, to create a society in which its members' use of electricity is characterised by high and improving efficiency, and with Swedish industry being a leader in terms of products and services for improving the efficiency of energy use. The programme aims to combine competence in the IT sector with design competence and knowledge concerning individuals' attitudes towards electrical energy, their everyday habits and use of technology. This is an applied programme, intended to result in a number of prototypes and demonstration activities:

• Attractive design solutions are intended to make individuals aware of their daily use of energy.

• Informative IT solutions provide detailed and usable information on energy and electricity consumption.

• Simple but at the same time advanced IT solutions that enable operation and control of residential energy use.

• Relevant and motivating decision making material that assists the move towards more resource efficient and energy efficient everyday habits.

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The Building as an Energy System

The vision for the built environment is that in the future, all energy should be used efficiently, and should be supplied from sustainable sources.

The overall objective is that the use of energy in residential and commercial buildings is reduced by 20 % by 2020, and by 50 % by 2050, both in relation to the 1995 level. Additionally, these reductions should be accompanied by a drastic reduction in the use of fossil fuels for heating purposes. As the rate of new building in Sweden is only 1 % of the total building stock per year, it will be necessary, if these targets are to be reached, to achieve the energy efficiency improvements mainly in existing buildings. This can be done through more efficient maintenance and operation of buildings, and/or by renovation and conversion. There is a substantial need for renovation and improvement of residential buildings constructed during the 1960s and 1970s, and it is essential to develop and spread the use of energy efficient designs for ventilation, insulation, windows, lighting etc.

Another important area of research is users' needs and improved construction processes. Investigations of the construction process look at how the various parties involved in the sector work together in the planning, construction,

operation and renovation of buildings. Other areas focus on how the amount of energy used can be reduced, and on how well occupants' needs are met by the features of buildings and by their services systems. Issues addressed are for example how buildings can be designed in order to make optimum use of solar heating, or conversely, how building services systems intended to distribute solar heat can be best designed to suit the plan, construction and appearance of the building. Research into occupants' behaviour, and into energy policy measures and physical planning, are also important in increasing the understanding of the entire energy system relating to buildings.

It is important that all those who influence, or who are affected by, the design of a building, from architects, via construction companies, building managers and operators to residents are involved in the renovation and conversion process in order to ensure maximum benefit of any improvement work. In this context, involvement of the management of construction companies is particularly important. The Swedish Energy Agency has therefore developed a comprehensive **programme for energy efficient building construction and facilities management (CERBOF)**, providing a forum for representatives of the construction sector and research organisations to investigate how energy can be used most efficiently.33 projects were started in this programme during 2008. Although present day technology can reduce the amount of energy used in buildings, new buildings are still generally designed and constructed in accordance with traditional principles and using traditional heat sources.

However, residential buildings can be designed and constructed so that the amount of energy that they use is less than half of the amount presently specified in building regulations. The term passive houses is used for houses where there is only a very modest input of additional heat over and above body heat from the occupants themselves, heat from electrical equipment and incident solar radiation. Instead, the reduced costs for a heating system are spent on well insulated floors, walls, roofs and windows, in order to ensure comfortable indoor conditions. The heat in ventilation exhaust air also needs to be recovered. The Swedish Energy Agency has run a demonstration programme under the name of '**Passive Houses and Low Energy Buildings**', with the aim of showing how new buildings in the future can use a minimum input of purchased heating energy. This objective will be achieved by improving general levels of knowledge and encouraging development of the necessary skills and awareness in the building industry.

Research Programme on Energy Efficiency in national heritage buildings – Save and Preserve

The Swedish Energy Agency has allocated 40 million SEK to energy efficiency in national heritage buildings during the period January 2011 - December 2014.

The programme covers projects of technical, antiquary, business economic and national economic point of views, within the following key areas:

- Regulation of indoor climate in decided to allocate 40 million SEK to energy efficiency in buildings
- System solutions
- Installations

Applied projects for energy efficiency in national heritage buildings and:

- Heated (continuously)
- Periodically heated (intermittent)
- Protection heating
- Unheated
- Operation and management/behavioural issues
- Building envelope
- Windows
- Solar shielding

There is considerable potential for energy efficiency in national heritage buildings, in Sweden and the rest of Europe. These buildings at the same time constitute a significant part of the so called national cultural heritage which shall be preserved. Even though consideration is taken to the special conditions for both older and buildings of national heritage, it can be noted that the work with energy efficiency in these buildings is neglected. Buildings of national heritage are regularly exempted from demands on energy efficiency, energy declarations etc. For the individual building there is often a lack of knowledge on how energy use can be reduced/more efficient in a way that does not threaten the values of the building. The general targets for energy efficiency in buildings do not however have to be in conflict with good building preservation. To combine the targets more knowledge, both on the technical and the antiquary side, is needed. As well a more developed dialogue between the two areas is needed.

The programme promotes long term capacity building through support for development of long term sustainable scientific environments working with:

- Compiling and supplying the knowledge and experience already existing, including outside of Sweden
- Developing the understanding/insight of the physical construction of older buildings
- Developing and demonstrating solutions for energy efficiency
- Integrating energy efficiency in building preservation and maintenance
- Training and informing the receivers

In the programme The Swedish Energy Agency works with among others the Swedish National Heritage Board; the National Property Board; the Swedish National Board of Housing, Building and Planning and the Church of Sweden.

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Research Programme on Energy Efficiency in the Area of Lighting

The Swedish Energy Agency has decided to allocate 60 million SEK to research for improved energy efficiency in the area of lighting. The programme constitutes phase two of a programme initiated in 2008. The new second phase will run for four years, starting January 2012 and run until December 2015. The aim of the programme is to direct research, education and technological development towards lighting areas where large benefits can be expected when it comes to energy efficiency while not losing out when it comes to function. The programme shall contribute to building up and maintaining a national competence in the area. This shall be done through supporting the whole chain of activities, from innovation, research, development, education, demonstration to market introduction, within the area of lighting.

The area of lighting is vast with a great savings potential. Lighting accounts for around 10 % of the total energy use in Sweden. Assessments show that there may be potential savings for electricity up 80 %. Lighting in private housing, in Sweden, account for about 4 TWh per annum. The electricity savings potential in the short term (changing to low energy light bulbs) should be around 2 TWh per year. Still light bulbs accounts for almost 60 % of all lamps. In the longer run with phasing in of LED-lighting the saving potential could most likely reach at least 3 TWh.

Sweden has a strong tradition as forerunner when it comes to environmentally friendly lighting in office space. In order for the buildings that are planned today to give a satisfactory indoor climate there is a need for lighting effects to be incorporated in the planning process, something that still is not taking place for the most part.

Energy efficiency is an important issue in the area of lighting but it has to be balanced against the need for a well-lit environment to secure productivity, wellbeing, security and health. Research has shown that good lighting can be satisfactory and create productivity, while bad lighting creates discomfort, fatigue and stress. An unhealthy indoor environment leads to a decline in productivity and increased absence due to illness. Light however does not only stimulate the response of the individual, but also effects its perception of a room, as well as emotional status and behaviour.

The programme supports research and development projects within the following areas:

- Reviews of current and expected development and demands on LED and other new light sources
- Technology of importance for steering of light (sensors, IT, optics etc.)
- Models/methods for energy audits and energy declarations of lighting for different premises
- Technology for simple exchange of light source when new and more efficient ones are developed
- Road and street lighting (for example LCC analyses for different kinds of road and street lighting)
- Creation of networks/centres for specialist and/or interdisciplinary cooperation groups within lighting research

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Transport

EU member states have a common commitment for the transport sector, for which a number of targets to be achieved by 2020 have been set within the EU. Among the most important of these includes a special requirement that 10 % of energy used in the transport sector should come from renewable energy sources by 2020. This is complemented by the Fuel Quality Directive, which requires suppliers of motor fuels in the EU to reduce CO2emissions, with effect from December 2008, by 6 % per unit of energy (as seen in a life cycle perspective) from the level in 2010.

In addition, there are requirements applicable to the automotive industry, under which the average value of energy efficiency of new cars within the EU must not exceed 130 g CO2/km, with effect from 2015. The same proposal sets a preliminary target of reducing this value to 95 g CO2/km for new private cars with effect from 2020.The Swedish vision for 2050 has four main areas:

- A transport system that is sustainable. Availability and mobility is good for everybody and efficient freight transport exists.
- The use of energy carriers that are CO2-efficient, and which have high system efficiency.

- Commercialisation of production technology for carbon dioxide efficient motor fuels.
- A successful automotive industry, producing energy efficient vehicles, and where Sweden will have a successful vehicle development industry.

An objective of the Swedish Government within the transport sector is to have a vehicle fleet which is free from fossil fuel by 2030.

Since environmental and energy supply considerations are one of the two greatest challenges for the transport sector, priority is given to achieve more energy efficient vehicles and renewable energy for replacement of fossil motor fuels. For the production of bio based motor fuels, priority is being given to projects that:

- Aim to achieve substantial reductions in greenhouse gas emissions from an overall system perspective, and equally low emissions of other regulated emissions.
- Have high system efficiency and a potential for large scale introduction and use, and which can also generate export revenues.
- Have a potential for achieving production costs equivalent to, or less than, the price of fossil fuels.
- On renewable motor fuels or energy carriers are particularly interesting if they:
    - Are suitable for use in the existing infrastructure (examples being ethanol and electricity).
    - Can be integrated with existing motor fuels and replace diesel.
    - Have synergy effects with other important export industries, e.g. the manufacture of pulp and paper.

For vehicle related projects, priority is being given to:

- Energy efficiency of vehicles and energy converters.
- Reduction of climate gases, primarily through reduced CO2/km emissions.

Project examples and research initiatives:

The Swedish Energy Agency is financing several large research projects covering the entire chain, from cultivation of raw materials for bio based motor fuels to the use of new fuels. Second generation bio based motor fuels and energy efficient carbon dioxide neutral solutions are the targets of work on second generation bio

based motor fuels. The concept includes conversion of forest raw materials and short-rotation crop: in addition, it involves the use of advanced new technology in efficient processes aimed at increasing the energy yield from the biomass. Gasification of biomass, for example, permits flexible choice of raw materials as well as of end products. Second generation motor fuels deliver a significantly better energy yield throughout the production chain than do traditionally produced bio based motor fuels. Sweden has three large development plants for the production of bio based motor fuels, which are partly supported by funding from the Swedish Energy Agency. The purpose of these plants is to establish a foundation for what are known as bioenergy combination plants, in which several processes operate together in order to provide maximum overall energy efficiency. In addition, research is being carried out at several universities directly linked to the plants. A recently revived interest in the production of bio based motor fuels means that more parties may become involved in research and development, as new stake holders in Sweden discuss whether to join the sector. One working area that will probably be expanded is biogas.

A **development facility in Piteå for gasification of black liquor** from the Smurfit Kappa Kraftliner pulp mill was commissioned in 2005. Its purpose is to develop gasification technology, and to investigate recovery or production of chemicals, electricity, heat and motor fuels from the process. The project was originally focused on the production of electricity and heat from synthesis gas. The Swedish Energy Agency is a financial partner of a cooperative element of the work between the USA and Sweden.

The **main focus of development today is to produce DME** (dimethylether), which can be used as a fuel in diesel engines. Crude synthesis gas produced in the existing gasifier will be used as a feedstock to produce 4–5 tonnes of renewable DME per day. This part of the work is partly financed by the EU Seventh Framework Programme, and is intended to develop and demonstrate the entire production chain from biomass to end use of a renewably sourced biofuel, which will involve field trials using goods vehicles developed by Volvo. The Piteå gasification plant has a capacity of 3 MW of fuel per day.

Örnsköldsvik – ethanol from cellulose Ethanol can be manufactured from cellulose by first breaking the cellulose down to simple sugars, which can then be fermented. The main thrust of ethanol research is to find ways of reducing production costs, for example through the use of cheaper and more efficient enzymes; improved strains of yeast that can ferment all the sugars encountered in the cellulose feedstock, and optimisation of the processes in such ways as reducing the amount of water and energy used. A pilot plant for investigating the entire process chain on a larger scale was set up in Örnsköldsvik in 2004. This plant is intended to be used for several years as a centre for development of the

process technology and as a test bed for research results produced by university departments.

1.2 TWh of biogas was produced in 2006 from various sources such as sewage sludge, food industry waste, stable manure and food waste that had been sorted at source. Current research in the biogas sector, which is being carried out at a number of universities and institutes of technology, is concentrated on process optimisation. In addition, a number of development projects for the production of biogas are on-going such as **Gothenburg Biomass Gasification Project – Gobigas** – producing bio gas by gasification of bio fuels and waste from forestry. The plant is expected to deliver in 2020 biogas equivalent of 1 TWh. It represents about 30 % of current deliveries in Gothenburg or fuel to 75 000 cars. Another important project is the demonstration biofuels plant based on Chemrec's gasification technology at the **Domsjö Fabriker bio refinery** in Örnsköldsvik, Sweden. The plant will produce the renewable and environmentally compatible biofuels bio methanol or bio DME using forest harvest residues as energy feedstock.

The Swedish Energy Agency supports research aimed at reducing motor fuel consumption as well as developing new technologies, such as, electric and hybrid vehicles. The efficiency of conventional petro land diesel vehicles must be improved, with reduced emissions and compatible for use with renewable fuels such as synthetic fuels, alcohols, gases or electricity. The greatest potential for energy efficiency improvement is found in vehicles used in urban traffic: by using electricity, energy use can be reduced significantly. The energy saving potential of vehicles used in long distance traffic is less. However, since heavy trucks mainly are responsible for the increase in traffic, even small improvements are may be of significant value. There are two national research programmes dealing with issues related to vehicle development, and five national centres. The programmes and centres are closely linked in order to benefit from common working areas and overall synergy effects between them. They also share a common business intelligence monitoring and analysis element. The following are brief details of the programmes:

- **The Strategic Vehicle Research and Innovation Initiative (FFI)** is a programme started at the beginning of 2009. It is split into five parts; Sustainable Production Technology, Vehicle Development, Transportation Efficiency, Vehicle and Traffic Safety, and Energy and Environment. The yearly budget is USD 100 million, half of which is government funding. About one third of the overall focus will be on safety, and two thirds on energy.
- **Energy Systems in Road Vehicles** is an academic research programme which is devoted to batteries, fuel cells and other components for vehicles

using electricity as a means of improving energy efficiency. The Swedish Energy Agency administers the programme. The programme, which ran until the end of 2010, had a budget of about USD12 million. To date, several PhD students in the field of hybrid vehicles and fuel cells have been trained, and a number of patents have been granted for new types of hybrid drive lines.

In 2010, Volvo Car Corporation was awarded 150 million SEK for a project aiming at demonstrating an electrically powered urban vehicle that can cover 90 % of the daily transport needs of a commuter. The project will conclude with 50 vehicles being demonstrated in actual traffic.

Energy-intensive Industry

In 2007, industry accounted for 39 % of the country's final energy use. Of this energy quantity, 79 % of the entire use of 156.6 TWh was used by the energy intensive sectors of pulp and paper, iron and steel, the chemical industry and the mining and minerals industry. Industry's main energy source is electricity, at 36 %, followed by biofuels at 35 %, fossil energy at 26 % and district heating at 3 %. These basic industries are characterised by high capital costs, which means that they are cautious when considering the introduction of entirely new technologies. It can therefore take some time before any new energy efficient technology has spread throughout an entire sector. Research is concentrated on problems and potentials such as:

- improving the efficiency of electricity use
- improving the efficiency when using fossil and renewable fuels
- increasing industry's own supply of energy to its processes, by better utilisation of waste heat, by-products and refuse material, as well as through own production of electricity
- supplying energy in the form of heat, fuels and electricity to nearby areas

Project examples:

LKAB in Luleå is involved in the major **EUULCOS (**Ultra Low Carbon di Oxide Steelmaking) project, the aim of which is to reduce carbon dioxide emissions from steel production by 50 %.

Another steel industry project is concerned with **improving the efficiency of the blast furnace process**. Blast furnaces are technically complicated, with several chemical reactions taking place at high temperatures. The interaction between the crude iron and the slag is particularly important. Controlling the formation process

of the slag and its final composition allows a cleaner crude iron to be produced with less energy. Slagging agents are traditionally loaded into the top of the furnace, but current research looks at the possibility of also injecting the slagging agent at a lower level in the furnace. This procedure has two advantages: different types of slagging agents can be used, customised for the respective zones in the furnace, and smoother, more stable and energy efficient operation is achieved.

For several years, the Agency has supported research on improving the efficiency of pulp production. Work in the **FRAM projects (Future Resource-Adapted pulp Mill)** has developed a process to produce a solid fuel from lignin in kraft mills' blackliquor. A development plant was inaugurated at Bäckhammar in 2007. The aim of these projects has been to produce the fuel as efficiently as possible, and to customise it for various applications. One benefit of lignin is that it can be recovered with a low moisture content, which gives improved efficiency. This technology is particularly attractive for pulp mills suffering from production limitations due to insufficient recovery boiler capacity. Lignin removal provides an opportunity to increase pulp production. The work has involved representatives from several stakeholders, ranging from pulp mill owners and equipment manufacturers to final users of the fuel. The Swedish production potential for lignin fuel is estimated as 5–10 TWh. The programme has been successful, and the patented process has been sold.

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Biomass in Energy Systems

Several reports have concluded that it is possible to almost double the Swedish supply of biomass. The 120 TWh produced from bio energy in 2007 is likely to increase by several tens of TWh in a few decades. Provided that suitable measures are taken, the bio energy supply is estimated to have nearly doubled by 2050, to 230 TWh. More efficient forestry should make it possible to increase the production of forest energy, mainly as by-products from forestry and the forest industry, while agriculture can deliver crops such as Salix, energy grass, hybrid aspen, grains, oilseeds, and various by-products from the food industry chain. The vision is that bio energy should achieve a dominant position in Sweden by 2020, and that export increases. Sweden can meet its commitments under the EU climate package in respect of its use of renewable energy by 2020 by using a further 25–30 TWh of solid biofuels and waste for energy supply to district heating and CHP, to industry and for individual heating systems. Most of this is expected to come from the forest, although the amount supplied by agriculture will also increase. Indigenous biomass will be used for the production of motor fuels, of which about 2 TWh may come from ligno-cellulose, and a certain amount of bio based motor fuels may be imported. Electricity from renewable

sources, biofuels and energy technology would be exported to other EU countries. Easily accessible biomass, such as forest felling residues and trimmings and bio products are already being used: more fuel chains need to be developed in order to permit overall expansion. The competition for biomass is expected to increase. The vision is that fuels from the forest should increase by 20–30 TWh, with an additional 6–8 TWh from agriculture, by optimisation of the entire fuel chain by growers and end users together. Harvesting systems for energy crops should be less weather dependent. The use of waste as a fuel should be optimised in order to apply its potential in the most sustainable manner. Bio gas production should increase, while peat needs to be harvested in a manner appropriate to environmental and climate considerations.

In order to reach the above mentioned objectives with more bio energy supply provided for the market, R&D needs to support activities that create:

- Improved production systems which are productive, energy efficient and appropriate to their environments. For the forestry sector, this means an ability to be able to harvest felling residues, stumps or entire small trees, and to increase production through appropriate use of fertilisers and other forestry practice
- Improvements in all stages of the production of Salix and other energy crops or waste products. As well as improved processes for the production of biogas

Increased production of bio energy increases the risk of environmental objective conflicts. Consideration needs to be taken to both national and international regulations and guidelines concerning sustainability and the environment. The vision is that production and use of Swedish bioenergy should meet national environmental objectives and should comply with EU sustainability criteria. To do so requires clear environmental guidelines for the production and harvest of all types of biofuels, meeting local and regional conditions. In order to minimise environmental objective conflicts, guidelines must be based on the values that society attaches to the necessary balances. The environmental added values of energy crops that take several years to grow must be considered and quantified. Heating plants using bioenergy must meet EU emission requirements. The vision presupposes research and development in several areas. There is a need to describe the environmental consequences of various ways of producing bio energy, and to transform this knowledge into the guidelines, which in turn need methods for striking a balance between environmental objectives. Methods of regional planning are needed in order to reduce the total environmental impact and to avoid sub optimisation. The positive environmental effects of energy crops must also be quantified and utilized. Combustion technologies must be improved, so that even small plants meet EU emission requirements, even when burning

high ash fuels or logs. Health effects of smoke from modern log fired boilers or stoves need to be further investigated.

An expected development is that large scale production systems for pellets will dominate, and production will increase. Exports of bio energy and bio sourced electricity will increase, while the production of pellets from sawdust will be quality assured and standardised. The vision entails that more raw material such as branches and tops, stumps, straw, peat and agricultural residues will be used as feedstock for large scale pellets production, producing an end product of a quality to meet customer requirements. Farmers would be producing and upgrading energy crops, while agriculture fuels and residues would be converted in both small scale and large scale operations. Waste would be processed to increase its suitability for such purposes as electricity production. Various stages of pre-treatment can result in intermediate products that facilitate both the physical supply and the trading of products. All this requires the following research and development. The production cost of large scale upgrading must be reduced by10 %. New processing and upgrading methods should be developed, concentrating on process control and quality assurance of the upgraded fuels. Primary processing methods should be developed to optimise fuel qualities for different methods of conversion. There is a need to demonstrate methods of large scale production of pellets from straw fuels/residues from the agricultural sector, together with production systems for small scale upgrading suited to various local conditions. Methods of pre-treatment of biomass, and storage without loss of substance, should be developed.

The importance of bioenergy for heat production in plants having a fuel input not exceeding 10 MW is increasing. Competitions for bioenergy that are more easily burnt, such as high quality pellets, thus mean that they are used primarily in domestic boilers and stoves. More demanding bio energy is used in larger plants where problems caused by such effects as higher ash content, poorer mechanical properties and varying moisture ratios, can be more easily dealt with.

The vision entails that the use of fossil fuels for heating should be phased out, and that electrically heated houses should be converted using biofuels or heat pumps instead. This would increase the small scale use of pellets by about 5TWh. Pellet firing systems for domestic applications must require a minimum of attention. About ten efficient CHP plants, with heat outputs of less than 5 MW, will be commissioned. In order to realise the above objectives R&D needs to support:

- Innovative systems for conversion of houses from direct electric heating, together with heating combinations involving the use of solar heating. The target is to ensure that at least 50 % of directly electrically heated houses can be converted.

- Development of new bioenergy fired boilers and stoves to ensure that the products meet the strictest EU emission requirements.
- Development of efficient CHP technology for thermal outputs of less than 5 MW (using a range of technologies and biofuels), as well as small local heating plants suitable for use with difficult grades of fuel.
- Development of recommendations for environmentally acceptable stumps harvesting, and looking into how the associated ground disturbances should best be avoided.

Increased international competition for bio energy highlights the question of supply, while fuel prices are rising. This provides a potential for export of upgraded bioenergy and other products. The vision for 2020 is that biomass for energy should be used where they deliver the greatest climate and supply benefits, with efficient use of resources at all stages. Society needs the necessary knowledge and skills to facilitate effective policy measures and optimum solutions. Accepted quality assurance systems will ensure that bioenergy from a wide range of raw materials can be used for various purposes. In order to realise these objectives R&D needs to support activities where:

- Bioenergy potentials and limitations, in relation to the overall climate and environmental work, need to be certain.
- Rational/optimal strategies for land use and processes for the production of bioenergy, foodstuffs and industrial raw materials are developed.
- The effects of national and international policy measures are clarified, through such means as international cooperation in this field.
- Decision makers are given the necessary knowledge of policy measures and incentives to ensure that development proceeds in the right direction without sub optimisations.

Even though development is already in progress, continued R&D input is needed in order to move forward and to improve the economics and overall performance of bio energy. The various parts of the system need to be developed in relation to each other, with a sufficient width of approach. In doing this the following areas have priority of importance:

- Improved cost and resource efficiency, with several fuel chains reaching the market
- Establishment of guidelines for meeting environmental requirements, sustainability and specific environmental targets

- The development of a broader raw materials base for primary processing, and the development of fuel quality suitable for different purposes
- Efficient conversion methods, suited to new fuels.

Project examples:

The **Skellefteå bio-combine Storuman** is a second-generation bioenergy combine. It produces electricity and district heating, and also dries raw material for the production of pellets, which provides a heat sink for electricity production in the summer when the demand for district heating is low. More such combined services plants will be needed in the future, producing various combinations of electricity, heat, cooling, steam, pellets, motor fuels, chemicals, animal feeds and biogas. The plant is the result of several years of research and development, in which the Swedish Energy Agency has been involved. The system is at present being verified, and is expected to show a higher overall efficiency than that of earlier plants. A commercial platform – Green Exergy AB– has recently been established, with the aim of launching the technology on various markets.

Södra Cell AB has been supported with 90 million SEK in order to set up a project that aims to create the prerequisites, via a full-scale demonstration, to commercialise the patented technology LignoBoost. This is a technology which has been adapted for the production of lignin in chemical pulp mills. The demonstration plant will be built at Södra Cell AB's facility in Mörrum. Through the installation of LignoBoost, high-quality biofuel is obtained in the form of lignin at the same time as the sulphate pulp factory receives a return on its surplus energy. The latter provides an incentive to further develop energy efficiencies. Seasonal variations in the mill's energy balance can also be accommodated more flexibly via the LignoBoost process as it provides a storable biofuel. The lignin obtained from LignoBoost is a high-quality biofuel which can replace fossil fuels such as coal and oil. This means that there will be a significant reduction in fossil CO2 emissions. The LignoBoost process increases the availability of biofuels in general and means that there will be a direct reduction in the use of fossil fuels, primarily as a result of the pulp mill's being able to use lignin as a high-quality biofuel in the mesa oven compared to the fuels available today. Lignin has a calorific value of between 26-27 GJ/tonne while sawdust and bark have calorific values between 18-20 GJ/tonne and in addition, they contain more elements which are disruptive to the production process.

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The Power System

The Swedish electricity system produces almost 150 TWh of electricity per year, based on hydro power and nuclear power, which together provide about 90 % of production. The remaining production comes from fossil-fuelled and bio fuelled capacity and from wind power. At present, wind power delivers about 5 TWh, but it is the Government's objective that wind power production should be able to expand to 30 TWh per year by 2020. Wind power will be the renewable energy source playing a dominant part in conversion of the energy system, and thus contributing both nationally and globally to reduced emissions of greenhouse gases, as a result of Sweden is expected to become a net exporter of electricity.

Today, Swedish electricity production is accounts for only modest carbon dioxide emissions, as it is based on hydro- and nuclear power production, together with the CHP plants which, largely, burn biofuels or waste. As most of the hydropower is produced in northern Sweden, while most of the power is used in the southern part of the country, the backbone of the Swedish grid is a transmission system running from north to south. The power system theme area includes research into the **wind power, solar electricity, wave power and the development and modernisation of hydropower and CHP production**. Important R&D areas for the new technologies include reduction of costs for electricity and reducing the environmental impact, while also developing simple and cost effective connections to the power grid with maintained reliability, safety and electricity quality. To this end, research into the transmission and distribution systems is concentrated primarily on Smart networks, i.e. management, supervision etc. In addition to the common problem areas, each electricity production method has its own important areas, such as the need to develop methods that facilitate establishment of wind power production in problematic areas, such as offshore, in cold climates or in forest areas. Sweden has a strong industrial presence in electric power, both in production and transmission. Most of the country's products in this sector such as cables and generators are exported. As industry is normally involved in research at an early stage, the work often results in practical application/commercialisation.

Wind

How large amounts of wind power can be integrated into the power system is being investigated from market and technical perspectives in some of the projects under the Vindforsk Research Programme. Studies have shown that it is not primarily the physical potentials for wind power production that limit its expansion, but factors such as the planning process, suitable tie points for grid connection and technical problems. One study concludes that 510 TWh/year could be produced in onshore plants and 46 TWh/year off shore. Technical problems for integrating wind power include system stability and the capacity of the system to deal with varying power inputs and problems of high-frequency transients. If the

realistic potential for wind power integration is to be fully exploited, there is a need to investigate performance in difficult locations, such as in cold-climate or forested areas. Establishment in cold-climate areas requires, for example, development of methods of de-icing or preventing the build-up of ice on rotor blades, and means of detecting and measuring ice formation.

Solar

The major advantage of Grätzel cells is that their production cost can be much lower than that of traditional solar cells based on crystalline silicon. The technology is now approaching the commercialisation stage, with several companies setting up both pilot-scale and full-scale production lines. Sweden is involved in this development through a joint project between Uppsala University, the Royal Institute of Technology and Swerea IVF in Mölndal. The university is conducting fundamental research into new dyes and electrolytes, and producing and characterising new cells. This research group is among world leaders in the sector. The fundamental research is complemented by the manufacturing of modules and development of the production process by Swerea IVF, with the long-term objective of manufacturing cost-effective solar cells for large-scale electricity production.

Wave

A demonstration plant of a wave energy converter concept has been granted 139 million SEK. The Seabased plant involves the largest wave power park ever to be built, now being set to become a reality. A total of approximately 420 wave power transformers will be manufactured in Lysekil in order to subsequently be placed into service and evaluated in the sea northwest of Kungshamn/Smögen in the Municipality of Sotenäs.

CHP

Research and development in the area of combined heat and power is concentrated on improving efficiency, reducing costs and tackling corrosion problems associated with the production of electricity from biofuels. The favourable conditions for CHP production from biofuels has meant that interest has increased in converting smaller boilers to CHP production. The results from many years of research into corrosion mechanisms by the HTC and KME material research programmes have meant that the industry now sees good prospects for taking a step forward through higher steam data from biofuel firing. A new research programme started in 2009, bringing together and filling in those gaps in knowledge which remain before the final objective of building a full-scale demonstration facility in 2015, having at least two percentage points higher

electricity production efficiency than that of present-day plants. A new four-year programme period was started up in the Swedish Thermal Engineering.

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Carbon Capture and Storage

The Swedish Energy Agency has brought together representatives from various sectors of industry to work in the field of carbon capture and storage, and have formed a new joint research programme.

NER300

During 2009 The European Commission lunched a call on financing of commercial demonstration projects aimed at the environmentally safe capture and geological storage of CO2, as well as the demonstration of projects of innovative renewable energy technologies. Sweden submitted 9 proposals, the second highest number of all European countries. After an eligibility check during 2011, 8 applications still remain in negation and a decision is expected in October 2012.

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13. Energy Technology – Business Development & Commercialisation

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Introduction: Commercialisation of Swedish Cleantech* energy** innovations

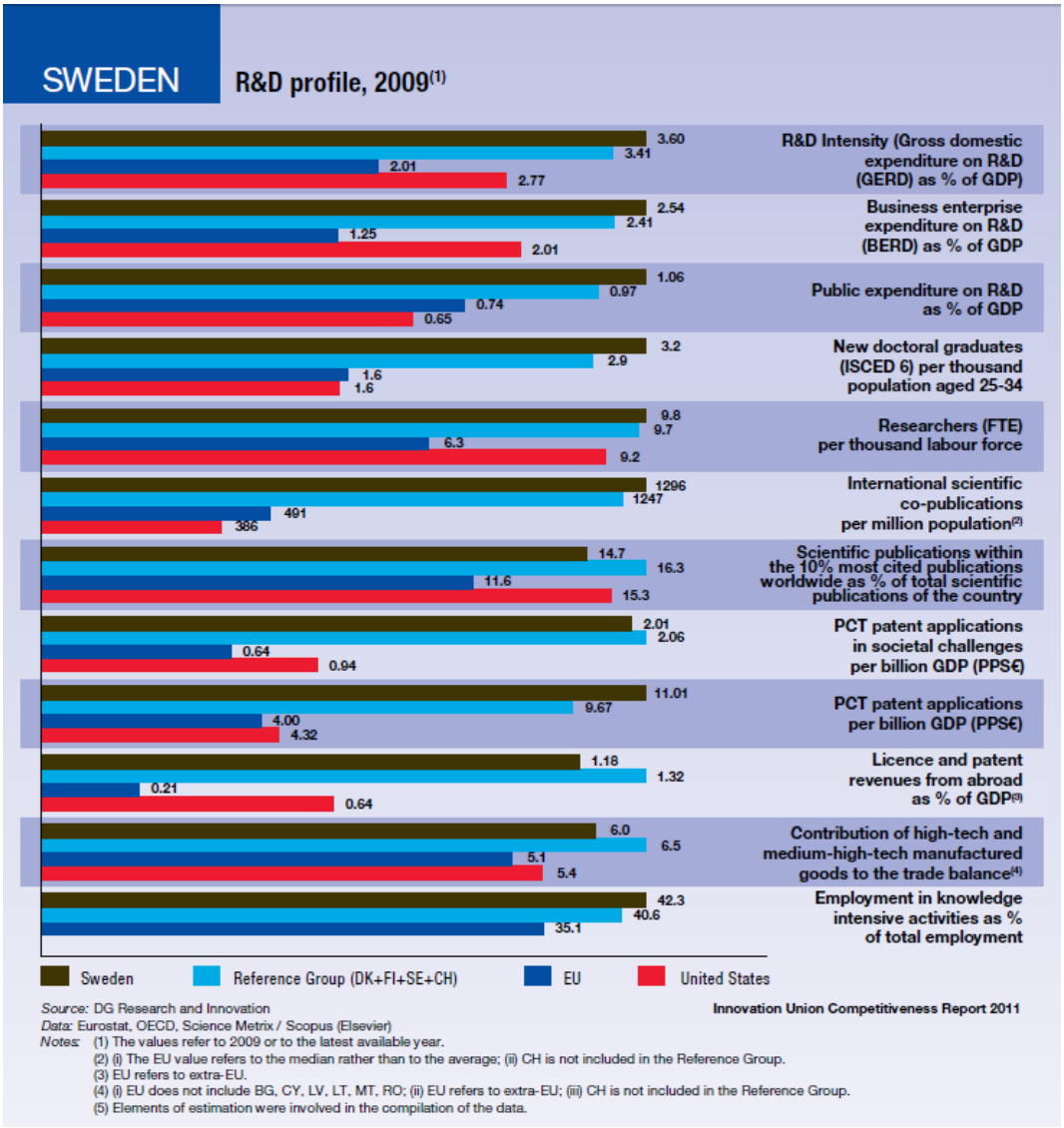
The on-going global transition to a sustainable and efficient energy system, paired with a greater concern for the ecosystem, creates an enormous demand for new products and services in the Cleantech sector. About 70% of all businesses in the Cleantech sector are considered to belong to the Cleanetch energy segment. The key driving forces for this transition stems from real needs that are tied to our use of natural resources, our security of energy supply and our influence on the eco system. Parallel to this, there is a strong and growing demand for energy in different forms and shapes.

The Cleantech energy sector in Sweden is strong. Compared to many other countries, Sweden stands out in that political policy measures has stimulated market growth to a higher degree than what market based factors has. Taxes; different support measures, subsidies, refund systems and other political measures has steered the development in a positive direction. Co-operation between municipalities, research institutions and the business sector have led Sweden to the R&D forefront in many areas. See figure 28.

**In this chapter we define the word "Cleantech" as synonymous to "Environmental technology", as defined in the Environmental Technologies Action Plan, ETAP. http://eur-lex.europa.eu/LexUriServ/site/en/com/2004/com2004_0038en01.pdf.*

***The expression "Cleantech energy" refers to the part of the Cleantech sector that comprises renewable energy and energy efficiency.*

Figure 25: R&D Profile for Sweden 2009



Innovation Union Competitiveness Report 2011

Reference: *http://ec.europa.eu/research/innovation-union/index_en.cfm?section=competitiveness-report&year=2011*

However, when it comes to commercialising R&D results, Sweden like many other countries, suffers from a general lack of capital in the early pre-revenue stages of the development of the businesses. Many venture capital actors that used to invest in early stage businesses have moved their focus to the later phases, which mean larger investments in fewer businesses. This also means that there are fewer possibilities for the remaining investor community for risk diversification through syndication. This gap in capital availability is called “The valley of

death", because of the fact that many innovations never reach the other end. See figure 29 below.

It is not unusual that new technologies within the Cleantech energy area also need large scale demonstration in a realistic production setting to convince potential customers. This demonstration will, in certain cases, require the construction of large demonstration plants. These demonstration plants are costly, and private financing is very difficult to obtain given the normally notable technical project risks. For reference examples, see chapter 12 (NER300 and project Södra Cell AB).

Cleantech energy innovations are, not always, but many times difficult to analyse from a business potential point of view. The investor community often lacks the expertise to analyse the business models, public support schemes' reliability, energy price forecasts and the potential market impact of an innovation in this sector.

On 1 September 2011, the Swedish government launched the *Cleantech Strategy*. The strategy aims to improve the conditions for growth and development of Swedish clean tech companies, to promote export and thus contribute to sustainable growth in Sweden, and to promote research and innovation within the clean tech sector.

13-A Policies overview including major changes since previous IDR

Current policy

Business development, commercialisation and deployment of new energy technology are important parts in realising the Swedish government's ambitions within the climate and energy politics. The Swedish Energy Agency supports actors within the Swedish industry to commercialise products and services that contribute to a sustainable and safe energy system.

The regulation for support to research and development and innovation in the area of energy (Förordning (2008:761) om statligt stöd till forskning och utveckling samt innovation inom energiområdet) is also relevant for the area Business Development & Commercialisation. The objective of the regulation is to promote energy research in order to create conditions for efficient energy markets, a secure energy supply and protection of the environment, health and climate.

Reference: http://www.notisum.se/rnp/sls/lag/20080761.htm

The Swedish Energy Agency works to support businesses acting in the renewable energy and energy efficiency field, present in the seed, start up and early growth stages.

Major changes since previous IDR

The above regulation, which came into effect in November 2008, is actually a transformation of previously approved schemes, made by Swedish authorities in order to bring them in line with the RD&I Framework as of October 2007, the EU framework for state aid for research and development and innovation.

Reference:
http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2006:323:0001:0026:en:PDF

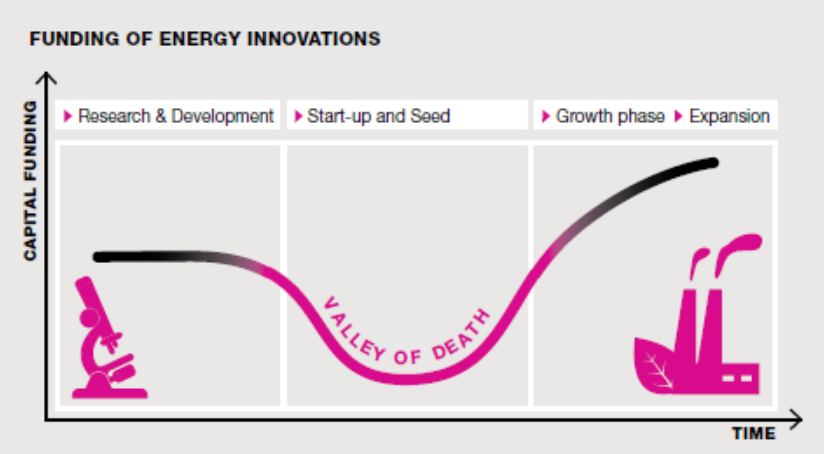
The major changes in possible support areas since the previous IDR, related to new businesses in the seed/start up stage, includes support for:

- Intellectual property right (IPR) costs for SMEs
- Technical feasibility studies
- Young innovative enterprises
- Process and organisational innovation in services
- Innovation advisory and support services
- Loan of highly qualified personnel
- Innovation clusters

New soft loan instrument

In 2010, a new financing instrument was introduced by the Swedish Energy Agency. This was done in response to that venture capital investments were moving towards a later phase of the investment cycle, creating a wider gap (valley of death) in availability of growth capital for businesses (figure 29).

Figure 26: Funding of Energy Innovations



The curve expands to the right, widening the gap.

The instrument is based on (2008:761) §16 "Support for young innovative enterprises", and has been practiced since 2010.

Objective for Business Development & Commercialisation activities

The Swedish Energy Agency's main objective is to achieve the right setting for the technologies, products and services that contribute to increased energy efficiency and/or an increased proportion of renewable energy in order to reach and develop on a commercial market, and thereby contribute to the development of the Swedish energy related industry and energy system nationally and globally.

The strategies to reach the objective include activities that promote increased professionalism in growth projects; facilitate growth project financing and a higher rate of commercialisation of research and innovation.

Commercialisation activities

The Swedish Energy Agency supports actors within the Swedish trade and industry to commercialise technologies that contribute to a sustainable energy system. The work aims to generate products and services from the research and development which has been supported by the Swedish Energy Agency, but also from individual innovators and spin-offs from existing companies. Experienced business professional's and legal advisors, work with business development activities, which are primarily aimed at three different target groups:

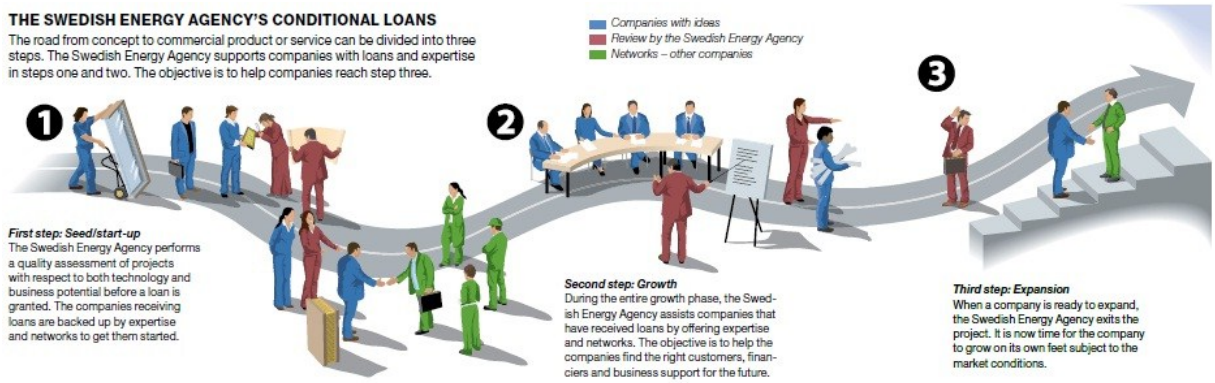
- Entrepreneurs/businesses
- Investors

- Other actors within the innovation system

Entrepreneurs/businesses

The Swedish Energy Agency offers soft conditional loans and business development support to businesses in the pre-commercial stage to the early growth stage. The businesses and their related growth projects are first pre-screened and then audited in a legal-, technical and business aspect. The audit is similar to the standard due diligence process made by venture capital investors. The Swedish Energy Agency sets the conditional parameters for each unique project, and also request project activities that will make the business attractive.

Figure 27: The road from concept to commercialisation



With the same purpose, the Swedish Energy Agency works actively with the businesses also after loan approval and supports them with knowledge (also as board members), network and promotional activities.

Investors

In order to stimulate commercial actors from the investment and finance community to contribute to the development and growth of the businesses, and further deployment of new technology, the Swedish Energy Agency is engaged in information activities. The purpose is to spread important knowledge in the Cleantech energy sector, which will have an impact on the development of this market. The target group for these information activities is mainly investors, and the aim is to serve them with important information that will reduce uncertainties, and thereby risk and ultimately stimulate an increased interest for investment in the Cleantech energy sector.

Innovation system

The Swedish Energy Agency supports other actors within the Innovation system

in Sweden by providing energy related competence that facilitates the completion of their undertakings. The Swedish Energy Agency also arranges conferences, seminars and networking activities for investors, businesses, politicians and the research community.

An important part of supporting activities, which also has the function to create an inflow of new innovative businesses to the Swedish Energy Agency, is the participation in different innovation- and business plan **competitions** held by other regional and national actors in the innovation system. The Swedish Energy Agency actively contributes with competence and networks from the energy sector in the evaluation of competing entries, and in some instances also with funding (see below):

The Swedish Governmental Agency for Innovation Systems, VINNOVA and the Swedish Energy Agency administer the competition **VINN NU**, where up to 20 businesses can win 300 000 SEK each for business developing activities. The Swedish Energy Agency evaluates all entries with energy relevance, and also funds the winners from this segment.

Forska & Väx (Research and Grow SBIR programme) is another call made by VINNOVA where the Swedish Energy Agency contributes. All entries with energy relevance are evaluated by staff from the Swedish Energy Agency, both from a technical and a business point of view. This includes visiting the contestants for interviews.

The Swedish Energy Agency also provides co-financing, competence and its network for the business plan competition **Venture Cup**.

The Cleantech Strategy

In February 2011 the Swedish Energy Agency, was commissioned by the Government to: in consultation with The Swedish Agency for Economic and Regional Growth, VINNOVA and other relevant actors and with a focus on early commercial stages, suggest measures for stronger cooperation and communication between state agencies, innovators, entrepreneurs, business angels and venture capitalists and other relevant actors in the Cleantech sector.

The purpose was to create a platform for the involved actors and thus stimulate increased investment in the Cleantech sector by private actors and also achieve better market conditions for business development in early stages.

Apart from suggestions for improved cooperation, conclusions should also include an analysis of any further measures and support actions from state agencies

needed to increase the supply of capital for Cleantech businesses in early commercial stages, with a focus on small and medium sized businesses.

Following the presentation of the Cleantech Strategy, the Government in November 2011 commissioned the Swedish Energy Agency to 2014 arrange a platform within which actors in various areas of Cleantech, innovators, entrepreneurs, companies, customers, financiers, government agencies and others, have the opportunity to network with each other and share knowledge and information. The purpose of the meeting place will be to promote collaboration between stakeholders and thus increase investments by private actors in Cleantech. Implementation will be carried out in conjunction with the Swedish Energy Agency's annual conference for the energy industry, but should also be take place through various centering activities between the annual conferences. Focus will be on the early commercial stages.

The Government also commissioned to the Swedish Energy Agency to broaden the market overview "Swedish Cleantech Opportunities", to include other aspects than just energy.

In carrying out these activities the Swedish Energy Agency shall consult with all other major state agencies that have Cleantech as one of their working areas.

Below is given a brief overview of some assignments to other national authorities with respect to the "The Cleantech strategy":

VINNOVA
Conducting a study focusing on research and knowledge development in Cleantech with emphasis on including sustainable urban development

Innovationsbron
Implementation of a program in incubator development, focusing on Cleantech.

Exportrådet (the Swedish Trade Council)
Especially focus on promotion of increased exports from small technology companies. This refers to both efforts to support and help with market analysis / establishment of small and medium enterprises management and development of the marketing concept "SymbioCity".

The Swedish Agency for Growth Policy Analysis
The Agency is tasked to monitor and evaluate the results of the efforts made in the context of "The Cleantech Strategy". These analyses are to be conducted and presented during the fall 2012 and spring 2014.

13-C Business Development & Commercialisation Priorities

The Swedish Energy Agency evaluates each business case based on its own merits.

When evaluating a loan request, the following aspects are central:

- Energy relevance; the business idea must be based on energy efficiency improvement or renewable energy
- Profitability; only businesses that has the potential to become economically viable are eligible for a loan
- The willingness to grow; an entrepreneurial spirit and business wits must be present with the management and board
- Uniqueness, scalability and protection; the business should have a product or service that can be protected by patent or by other means. It should be scalable and unique
- Co-financing must be present: a part of the project must be financed by other, non-state aid parties than the Swedish Energy Agency

13-D Division of responsibilities and decision making process

In regards to Energy Technology – Business Development & Commercialisation:

National

- Näringsdepartementet (Ministry of Enterprise, Energy and Communications)

The Division for Energy within the Ministry of Enterprise, Energy and Communications has an overall co-ordination and planning role for Swedish energy policy.

- Statens Energimyndighet (Swedish Energy Agency)

The Swedish Energy Agency is the only organisation in Sweden with the assignment to promote commercialisation in the energy field by explicit aid that supports introduction of new energy related products and services in the market.

- VINNOVA

The Swedish Governmental Agency for Innovation Systems, VINNOVA, is a Swedish government agency under the Ministry of Enterprise, Energy and

Communications and the national contact agency for the EU Framework Programme for R&D. Funding decisions are made following public calls for proposals under VINNOVA's programmes. The Agency does not have a sector focus.

Reference: http://www.vinnova.se/en/About-VINNOVA/

- Innovationsbron

Innovationsbron works with commercialisation of R&D results by grants, soft loans and early/seed equity investments. Innovationsbron's role is to act as a market complementary and its efforts are focused on projects and companies in the very early stages of development. Another role of Innovationsbron is to administer the national incubator programme. It was formed by Teknikbrostiftelserna, Industrifonden and the Government with the support of VINNOVA and started its operations in spring 2005. It is a national company with offices in Luleå, Umeå, Uppsala, Stockholm, Linköping, Gothenburg and Lund. Innovationsbron is owned by the State and Industrifonden. The organisation does not have a sector focus.

- Industrifonden

Industrifonden is an independent ever-green venture capital fund, founded by the Swedish government in 1979. The company operates on a commercial basis and receives no public funding. The fund offers venture capital, competence and a network of contacts to small and medium-sized companies with international growth potential. The company invests in small and medium-sized Swedish companies with international growth potential. Investments are made on commercial terms together with entrepreneurs and other investors. The sector focuses of Industrifonden are: IT & telecom; communication technology; electronics; life science & industry; energy- and environmental technology.
Reference: http://www.industrifonden.se/en

- Fouriertransform.

Fouriertransform is a state-owned venture capital fund with a mission to, on a commercial basis; strengthen the international competitiveness of the Swedish automotive cluster by strategic investments. The company was instigated in 2009 by the Swedish government as a response to the deep crisis in the Swedish automotive industry. The sector focus is the automotive industry.

Reference: http://www.fouriertransform.se/en/

- Cleantech Inn Sweden

Cleantech Inn Sweden is a national initiative designed to facilitate and promote the early commercialization of Cleantech innovations. The organization is commissioned by the Swedish Ministry of Enterprise, Energy and Communications to create a nationwide organisation. The primary objective is to speed up sustainable growth by focusing on Cleantech innovations at an early stage in companies that have growth potential. It is owned by Innovationsbron and financed by Vinnova, Tillväxtverket, Region Skåne and Västra Götalandsregionen. Sector focus: Cleantech.

Regional

- Tillväxtverket (Swedish Agency for Economic and Regional Growth)

The Swedish Agency for Economic and Regional Growth has been tasked by the Government to support initiatives that help people realise their business concepts, and it runs a number of programmes, initiatives and projects with the aim of generating more and growing businesses. The Agency has no sector focus.

Reference: http://www.tillvaxtverket.se/ovrigt/englishpages.4.21099e4211fdba8c87b800017332.html

- Almi Företagspartner

Almi works with promoting the development of competitive small and medium-sized businesses as well as with stimulating new enterprises with the aim of creating growth and innovation in Swedish business life. Its activities cover the whole process from idea to profitable business. Almi Företagspartner AB is owned by the State and is the parent company of a group of 17 subsidiaries, which are 51 per cent owned by the parent company. Other owners are county councils, regional authorities and municipal cooperative bodies. The boards of the subsidiary companies are made up of politicians, local business representatives and organisations with links to the business world. Operational activities are run in the regional companies. Almi's lending activity is self-financed. Management and day-to-day operations are financed by annual grants from the owners. The organisation has no sector focus.

Reference: http://www.almi.se/ALMI-in-English/

- Inlandsinnovation

Inlandsinnovation is a regional, state owned, venture capital actor. The geographic delimitation is the northern Swedish inland. It was established in 2011. They offer loans, loan guarantees and direct equity investment. The company is located in Östersund. No sector focus.

- Norrlandsfonden Foundation

The Norrland Fund originates from the state-owned minerals group LKAB. It was established in 1961 with the task of promoting development in the northern businesses, by financing small and medium enterprises. The fund provides last mortgage loans for start-ups, development and expansion, primarily to small and medium-sized manufacturing and service-providing enterprises in Northern Sweden. Norrlandsfonden operate in the five northernmost counties of Sweden. The head office is in Luleå. No sector focus.

- University Holding.

The first set of University Holding companies in Sweden were established in 1994. There are today 15 regional University Holding entities in Sweden with the main purpose of fulfilling the "third task" for the educational system, being to deploy R&D results. All University Holding companies are fully owned by regional universities. The main activities performed in each University Holding company can be divided into commercialisation of advanced research and general entrepreneurial activities. The sector focus varies among the regional entities depending on any eventual speciality of the connected university.

For more information please read chapter 3 in the publication *Public actors in Sweden's national innovation system* in the publication, part of the report "THE PERFORMANCE AND CHALLENGES OF THE SWEDISH NATIONAL INNOVATION SYSTEM" by Swedish Agency for Growth Policy Analysis, 2011.

13-E Funding

See below under 13-F.

13-F Evaluation

The soft loans from the Swedish Energy Agency provide liquidity in growth projects and leverage to private investments. The demanding due diligence activities and market exposure provided by the Agency creates businesses that are attractive for investors and facilitates commercialisation of their innovations. The information and knowledge dissemination actions contributes to an increased interest for private equity investments within the energy sector and facilitates the participation of other innovation supporting actors to also assist in the development of the businesses, and further deployment of new energy technologies.

In order to accomplish a positive development in businesses with growth projects, and a commercialisation of the innovations from these businesses, a multiplicity of related measures needs to be accounted for, and it is difficult to extract the exact effects of the activities originating from the work done by the Swedish Energy Agency.

However, the effect is estimated on a yearly basis by measuring different relevant parameters in the businesses that have received soft loans. See table 22 below. Please note that the figures include only active projects each year, which means that all figures from ended projects are removed from the table.

Table 23: Effects of Business Development & Commercialisation activities 2009-2011

Measured Parameters	2009	2010	2011
Collective turnover	32 900 000SEK	57 900 000 SEK	73 700 000 SEK
Turnover, export markets	4 000 SEK	19 000 000 SEK	20 400 000 SEK
Number of employees, December 1st	109	195	134
Private equity raised each year	41 200 000 SEK	183 000 000 SEK	99 321 000 SEK
Customers, December 1st	415	244	595
Partnerships, December 1st	41	65	64
New Products each year	15	65	13
New patents each year	9	24	24
New loans approved each year	12	10	8
Amount lended each year	61 338 000 SEK	34 751 000 SEK	40 020 000 SEK

13-G International collaborative efforts

The objective for the Swedish Energy Agency, in terms of international collaborative efforts, is to develop and carry out promotional activities for Swedish energy technology in close collaboration with other state and private organisations, with the purpose of contributing to a sustainable economic growth and the development of the energy system in Sweden and abroad.

The Swedish Energy Agency focuses its international collaborative efforts partly with countries where energy related bilateral agreements are in place, such as the United Arab Emirates; India; China, United States and Russia, and partly on the markets with the greatest potential for Swedish Cleantech export such as western Europe and Japan.

Several activities during 2011 have been conducted within the international arena with the purpose of strengthening the Swedish Cleantech energy sector.

- Participation with a Swedish pavilion at the World Future Energy Summit in Abu Dhabi (in 2011 and 2012), where 26 Swedish Cleantech businesses were exhibited and promoted by high level Swedish officials.
- A joint Nordic pavilion and Swedish participation at the GreenBuild International Conference and Expo in Toronto. Fifteen Swedish businesses in the field of green buildings and energy efficiency in buildings participated.
- Two Cleantech seminars at the Middle East Summit in Doha, Qatar, where five Swedish businesses presented their energy technology innovations.
- A Swedish pavilion and high-level seminars together with the Department of energy in South Africa at the COP17 in Durban. Ten trade associations, five businesses and the Swedish Minister of the Environment participated.

Recent international agreements conducted by the Swedish Energy Agency are:

- Support of a three year cooperation agreement between the Swedish Biogas Association and Bio Business Alliance of Minnesota. The purpose of the project is to evaluate, facilitate and create the right conditions for building replicable reference plants for bioenergy systems, with the Swedish competence and technology that is included in the bilateral cooperation Swedish American Green Alliance (S.A.G.A). The long term purpose is to create growth and jobs in both Sweden, by Swedish service- and technology export, and Minnesota that is enabled to convert to a resource efficiency and sustainable bioenergy economy.
- An agreement has also been signed between the Swedish Energy Agency and the Russian Energy Agency within the areas of energy efficiency improvement and renewable energy. Two seminars, about green certificates and biogas for transport, have been conducted with the Russian Energy Agency.

13-H Involvement of the Private sector

The major part of the efforts to involve the private sector is made with respect to creating and improving investor relations. Targeted investors are early stage investors such as business angels, venture capital funds and corporate venture capital. Some of the main activities made for this purpose include exhibitions, publications, road shows and other events.

Exhibition and pitching contest - Energiutblick
Businesses that are granted loan financing by the Swedish Energy Agency have

the possibility to participate at the yearly at the annual conference "the Nordic Energy Outlook" -"Energiutblick", with more than 2000 visitors. A normal year twelve companies exhibit and eight businesses compete at the pitching event "Swedish Cleantech Business Award". A competent external jury of five, with relevant investment experience, ensures a high standard for the event. Each contestant has been adequately trained prior to the event. Investors described above are invited to this event.

Publication – **Swedish Cleantech Opportunities**
In line with the aim of increasing the interest for investments within the energy technology field, the Swedish Energy Agency produces and distributes the annual publication "Investera i Cleantech". The publication is a market overview that includes articles describing recent investment cases together with information about interesting businesses in the portfolio of the Swedish Energy Agency; statistics; trends and political objectives within the sector. The publication is also translated to English with a circulation of 2000 pcs.

Reference:
http://webbshop.cm.se/System/TemplateView.aspx?p=Energimyndigheten&view=default&id=ed464548dd644f5eb8398e9178202f56

Road shows have been conducted targeting the investment community with the twofold purpose of collecting information and inform about the activities that stems from the Business Development & Commercialisation unit of the Swedish Energy Agency. The two target groups that were identified are: Venture capital firms, and secondly private investors (Business Angels). Both categories make equity investments. Once charted, if we find a mutual interest, the contact is added to our investor network and is supplied with information about investment opportunities and invited to events and exhibitions arranged by the Swedish Energy Agency.

Event - Greentech Day
The Swedish Energy Agency arranges the Greentech day together with the Swedish agency for economic and regional growth and the Swedish Association of Graduate Engineers. The event is aimed to increase the private sector knowledge of the different support programmes that are available from both a national and regional perspective.

13-I Noteworthy projects and research areas

The department for Business Development and New Ventures at the Swedish Energy Agency was established in 2006. One of the first businesses to benefit

from the then new soft loan instrument “Business development loan” was **TranSiC AB.**

TranSiC AB conducted advanced research and development on bipolar SiC transistor technology, and has during the project demonstrated industry leading efficiencies and excellent performance over wide temperature ranges, and superior performance over MOSFET and JFET technology approaches. Used in the power converter in Hybrid Electrical Vehicles (HEV), the TranSiC power transistors dramatically enhance the total power efficiency. The conditional loan from the Swedish Energy Agency was co-financed with equity issued to three Swedish venture capital firms. In 2011 the owners of TranSiC made an exit and sold the business to a US corporation, Fairchild Semiconductors Inc.

Figure 28

Refernce: http://www.transic.com/ http://www.fairchildsemi.com/

Midsummer

The CIGS-PV research started en the 1970: s. The aim was to move away from silicon based PV cells in order to reduce material costs. The focus of the research activities has been to achieve better efficiency. It has been successful and the efficiency is now close to standard silicon PVs. Midsummers unique ideas was to combine this research with knowledge from the highly automated production process from CD/DVD production, using stainless steel substrates, and bring down the costs of electricity production to the current market level (grid parity). Midsummer AB received a soft loan in 2007 to commercialise the concept. In 2011 the factory was ready, and the production level is currently at 5MW thin film PV cell effect per year.

Reference: http://www.midsummer.se/

Figure 29

Proforestry AB, another business that has been supported by the commercialisation work at the Swedish Energy Agency, has developed a poison free, mechanical forest pest control that protects against damage by the pine weevil. At present nearly 300 million forest plants are treated annually in Europe with poison against the pine weevil. Without protection the majority of the plants planted will die, with substantial economic losses as a result. The product, MultiPro, consists of a specially formulated degradable sleeve, which gives the plant protection against the pine weevil, but which is also designed to protect the plant against being dried out as well as to give it a quick initial growth. By enhancing the plant's vitality in a number of crucial ways, MultiPro creates good preconditions for rapid establishment and a high survival rate among the planted forest plants. The MultiPro was commercialised and launched in 2011.

Figure 30: MultiPro

14 Peat

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14-A Policies overview including major changes since previous IDR

Major changes since the previous IDR in policy affecting peat and its competitiveness

Altered CHP taxation as of 1 January 2011: From 15 % to 7 %, of 105 öre/kg CO^2- emission for heat production within EU-ETS, and from 21% to 30 % for heat production outside the EU-ETS.

Expansion of the electricity certificates market to include the Norwegian market took place 1 January 2012. Peat will, however, not be eligible for electricity certificates in Norway.

General Overview

In May 2003 the electricity certificate system was introduced in Sweden. As of 1 April 2004 electricity from CHP fuelled by peat is eligible for electricity certificates. Moreover, emissions from combustion of peat are included in the EU ETS.

Peat is not treated as coal in Sweden, rather something in-between biofuel and fossil fuel. For tax purposes peat is regarded more as biofuel, and is hence not subject to any carbon dioxide tax or energy tax. Sulphur tax however is charged on peat.

In December 2010 the Swedish Energy Agency presented an investigation to the government concerning the possibilities of a climate adjusted peat operation based on calculating the net-emissions over a life-cycle.[31] The investigation showed that peat extraction under optimal conditions can have a more favourable environmental impact than if only considering the emissions from the burning of peat. Avoided methane and carbon dioxide emissions from the peat and increased net photosynthesis after peat extraction contribute to a lower total net emission. A similar investigation with similar results was conducted in 2007 and presented in March 2008.

[31] *Uppdrag om underlag avseende torvanvändning och växthusgasbalanser*, ER 2010:43

14-B Previous IDR recommendations

The government of Sweden should:

- *Balance the environmental burden of peat with a more appropriate peat taxation policy.*

Action taken:

No action has been taken in regard to this recommendation.

14 -C Demand

Peat is used for energy and horticultural purposes. In 2010, peat accounted for 0.6% per cent of Sweden's TPES (total primary energy supply) which is a decline from 0.7% in 2009.

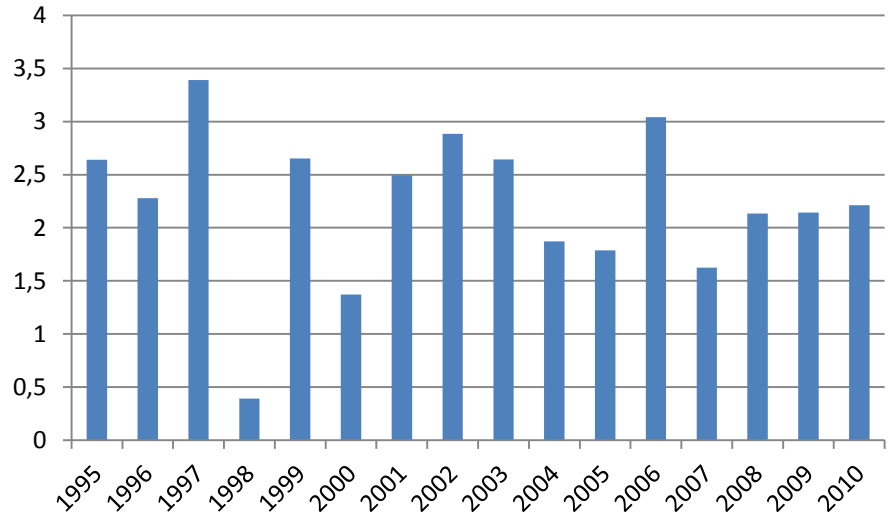
Total peat use for energy production in 2010 amounted to 4.3 million m³ which is the equivalent to 3.8 TWh or 330 ktoe, and at the same level as the previous two years.

Around 30 of the larger heat plants, and 22 CHP plants, in Sweden use peat as fuel. The vast majority of these use peat in conjunction with biofuel. In heat and CHP plants peat fuels are, for combustion technical reasons, often co-combusted in fuel blends together with bio fuels due to co-combustion benefits. In 2010 the main energy peat use was for heat production in heat boilers while only 25 % was used for electricity generation in CHP plants. A smaller amount (0.03 TWh) was used for extraction of minerals and in the manufacturing industry.

14-D Production

Indigenous peat is harvested both for energy and horticultural use. In 2010, 2.2 million m³ peat for energy use was harvested which corresponds to the average yearly outtake for the last ten years, see figure 7.

Figure 31: Production of energy peat (million m³)



Source: SCB and SGU

The harvesting of peat for horticultural use in 2010 amounted to 1.25 million m³ which is around the same as for the last ten years.

14-E Reserves

All peat deposits in Sweden, covering almost 25% of the country, is formed during the last 10 000 years after the glaciation. 6 million hectares is covered with peat thicker than 30 cm and almost 10% of forest growth in Sweden is on partly drained peat soil. Peat is continually generated by accumulation of annual growth of vegetation on top of the peat. The extraction of peat is a small fraction of the net annual accumulation of new peat.

14-F Imports and exports

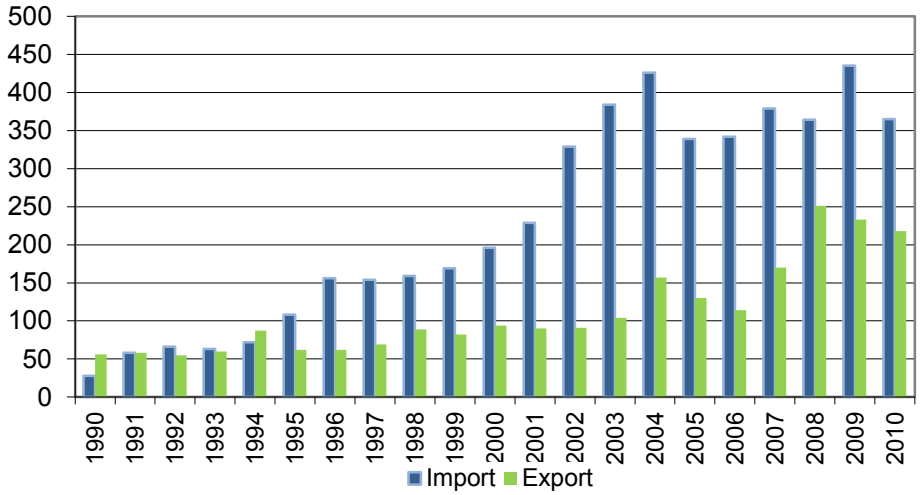
There is no differentiation for statistical purposes between energy peat and peat for horticultural use. Imports are, however, predominantly energy peat whereas exports are mainly comprised of horticultural peat.

Total imports in 2010 amounted to 365 000 tonnes which is a decline by 16 % from 2009. The share of imported peat in energy peat use is around 32 %. Estimations show that around 68 % is imported from Belarus and 21 % from Finland.[32] The total import is valued at 218 MSEK.

[32] Due to EU-regulations logging the country of origin is no longer made for imports within the EU. There is hence an uncertainty to the estimations.

Exports in 2010 amounted to 218 000 tonnes which is a decline with 6 % since the previous year. Primary recipients are Holland, Finland, Denmark, Belgium and Norway. The total export is valued at 173 MSEK.

Figure 32: Imports and Exports in kilo tonnes



Source: SCB, Utrikeshandel

14-G Industry structure

There are around 15 producers of energy peat across the country. While some producers have but one customer others supply several. Trade is usually regulated be means of contracts running several years. There is also a spot market as a consequence of especially productive years. The production capacity varies greatly from 5000m³ to a million m³.

The leading supplier of peat in Sweden is Neova AB, holding 65 peat concessions and supplying 23 combustion installations, with ca. 250 employees. Neova AB is part of the Finnish Vapo Group. Vapo is the world's leading supplier of peat with production in Finland, Sweden and Estonia. The Finnish State owns 50.1% of the shares in the parent company, Vapo Oy, and Suomen Energiavarat owns 49.9%.

14-H Subsidies

The electricity certificate system is a market based system subsidising renewable electricity generation, including peat. 1 MWh produced electricity (from renewable source or peat) entitles one certificate sellable on the market.

14-I Pricing

There are no regulations governing the pricing of peat as prices are set by the market.

References:

- Government bill 2009/1041:41. (Regeringens proposition 2009/10:41, Vissa punktskattefrågor med anledning av budgetpropositionen för 2010.)
- *SCB Torv 2010*- MI 25 SM 1101
- Uppdrag om underlag avseende torvanvändning och växthusgasbalanser- ER 2010:43
- Elcertifikatsystemet 2011- ET2011:32