DYNAMIX

Decoupling growth from resource use and environmental impacts

DYNAMIX policy mix evaluation

Reducing fossil fuels use in Sweden

European Commission

SEVENTH FRAMEWORK PROGRAMME

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AUTHOR(S)

Francesco Bosello, Fondazione Eni Enrico Mattei (FEEM)

With contributions by:

Doreen Fedrigo-Fazio and Ana Faria Lopes, IEEP

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DYNAMIX PROJECT PARTNERS

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1 Resource/Issue

Name of resource targeted (or focus of the case study, if the policy mix is broader than the specific resource(s) we have decided to analyse).

This case study refers primarily to the use of fossil fuel resources, but also to a "clean atmosphere" as a public good/resource, analysing energy and climate change policies.

2 Geographical area of policy mix coverage

Country name, and region or city if appropriate (if policy mix is applied regionally or locally)

The scope of this study is Sweden.

3 Policy context

3.1 Needs assessment: The environmental problem /resource challenge

What is the environmental problem/concern (consider both quantity and quality), e.g. soil erosion, excessive use of non-renewable or renewable resources and the crossing of environmental thresholds/tipping points for impact, resource scarcity concerns?

Are there any economic or social problems related to the issue and environmental problems – e.g. is there important price volatility, (risk of) unavailability of resources for the economy or society?

Who is the target group affected that have been, are or will be beneficiaries of the policy response?

Climate change effects are a global challenge and will affect many Swedish economic activities, as temperature rises and patterns of precipitation change.

In addition to environmental concerns posed by climate change and environmental degradation, carbon and energy efficiency policies pursue two other goals: reduce energy dependency from non-reliable energy exporters and to raise revenues (energy tax). This goal was originally attributed in Sweden to the energy tax, while the correction of the environmental externality to the CO_2 tax. But disentangling the two instruments from the two objectives is in practice quite difficult.

There are **economic, social distributional and competitiveness problems** related to the issue and environmental problems. The society as a whole should benefit from lower negative impacts from climate change and for more secure energy. Climate change impacts tend to affect more severely weaker social groups, which are more exposed and less adaptable. In this sense, climate change and energy efficiency policies may have positive distributional effects benefiting the poor. However, they may also exert negative effects on poor

households through increased energy prices and energy intensive industries through higher competitiveness.

Some of the effects per sector are described below:

Transportation Networks

The expected increase in precipitation, flow rates, flooding, risk of landslides and risk of damage to roads as well as the reduced depth of ground frost may increase road deformations. Moreover, higher temperatures and groundwater levels may increase road and railway rutting. The expected rise in temperature during the summer brings an increased risk of sun kinks. Stronger winds, particularly in Southern Sweden, may bring an increased risk of storm felling of forest and of damage to the power supply for the railway network. A higher water level may have an adverse impact on port activity, particularly in the southernmost parts of the country. On the other hand, a reduced frequency of sea ice implies that winter shipping in Swedish ports becomes easier, particularly along the coast of Northern Sweden.

Telecommunication Networks

Telecommunications with overhead power lines and masts will have an increased risk of storm felling due to lower frequency of ground frost and increased extreme wind speeds.

Settlements

Waterside development will be exposed to more frequent flooding in particular in the western and south-western parts of the country, increasing the risk of damp and mould on buildings due to the warmer and damper climate.

Drinking water supply and wastewater management

In the south-eastern parts of the country, there is an increased risk of water shortage whereas in the northern parts of the country precipitation is expected to increase, leading to flooding events. The increased risk of floods, landslides and landslips may also mean that pollution from contaminated soil and old landfills can be dispersed. In conjunction with floods, upstream of water sources pollution may be carried to lakes and watercourses, including the risk of spread of waterborne infection and viruses. The quality of the raw water in water sources will be adversely affected as a rise in temperature results in increased leaching of nutrients and humus, leading to brown-coloured water and increased eutrophication.

The piped distribution of water may be damaged by landslides due to downpours. A rise in sea level may increase the risk of saltwater penetration into wells close to the coast in Southern Sweden.

Higher frequency of extreme rainfall increases the risk of sewage pipes being overloaded that in turn lead to frequent and extensive overflowing of sewage, increasing the risks to human health. There is also an increased risk of back-flowing water and flooding of basements.

Supply and use of energy

A climate with milder winters means that the need for heating in the residential and service sector will decrease sharply but, as summer temperatures increase, the need for cooling will increase. Overall, the demand for energy is expected to decrease, implying cost savings for consumers. Hydropower production is favoured by an increase in water inflow and a more

balanced annual rhythm of water flow. However, heavy rains may cause dam bursts in the hydropower industry, which may have extensive consequences for society. The effect of climate change on wind power production is unclear: the energy content of wind is expected to increase in the long term in the Baltic Sea region, increasing production of wind power, while excessive windy conditions and icing may hinder wind power production. Bioenergy production is also expected to increase in a milder climatewith a longer growing season. Thus, changed climatic conditions may have serious consequences for security of supply in the energy sector.

Forestry, agriculture, fishing and tourism

Climate change is expected to increase timber production as a result of a longer growing season and a higher level of carbon dioxide in the atmosphere. However, faster growth may mean lower quality and greater risk of frost damage, as extended growth will begin earlier in the spring.

A change in wind patterns and higher frequency of ground thaw may result in more trees being brought down by storms. Insect and fungal attack may also become more common with a warmer and wetter climate.

Agriculture productivity in Sweden is favoured by a warmer climate and a higher level of carbon dioxide in the atmosphere, implying higher and new crop production. But a warmer and damper climate is also favourable to pest growth, plant diseases and insects, and water availability for crop irrigation may vary due to the variety in precipitation patterns across the country.

The warming of the Baltic Sea combined with a decrease in salt level might threaten the survival of economically important fish species such as Baltic herring, cod and salmon. In freshwater sources, cold-water fish species will be replaced by warm-water species, having unclear effects for fisheries on the west coast.

The change of habitat can also affect reindeer herding, consequently threatening Sami culture.

Conditions for summer tourism will benefit from warmer summers, in particular bathing tourism and outdoor leisure close to seas and lakes. An important issue for the trend in summer tourism will be water quality and algal bloom in the lakes and seas of Scandinavia. The season for many ski resorts in Sweden will be shortened and winter tourism activities such as cross-country skiing and snowmobiling will be negatively affected as it is not possible to produce artificial snow for these activities.

The natural environment and biodiversity

Climate change will affect biodiversity directly through temperature and precipitation change and indirectly through land use changes. The areas of bare mountain in Sweden are expected to decrease substantially as the tree line rises. Downy birch forests will shrink as the snow cover becomes thinner and less permanent, while along the mountain slopes pine and spruce tree species will become more dominant. The temperature and sea level of the Baltic Sea will rise, the ice extension will decrease dramatically and the salinity in the Baltic Sea is expected to change due to changed wind patterns and increased precipitation and inflow from

watercourses. The effect on salinity levels is still uncertain since there are great uncertainties in the wind and precipitation scenarios.

Human health

Elderly persons and individuals with cardiovascular and lung diseases may be particularly affected due to severe heat waves. As temperatures increase, the length and intensity of the pollen season also extends with a possible increase in pollen allergies and high summer temperatures may also increase the risk of infections spread in food and water. On the other hand, a milder winter climate will reduce the number of cold-related health problems. The risk of flooding may also have direct consequences for human health as drinking water quickly becomes polluted, due to sewage overflow or water from polluted land reaching water sources. Change in ecosystems may imply new diseases entering the country, particularly vector-borne diseases.

3.2 Policy context and policy needs

What policy challenge(s) did the problem pose and what policy challenges does it still pose?

What is the policy context related to the policy mix being evaluated? What policies have been put in place to address the issues, what policies are currently in place and which ones are already foreseen for future introduction (e.g. to address past, existing and future objectives)?

What sort of policy response did (and does) the problem call for?

Climate change also poses important distributional concerns that need to be addressed by policy. On the one hand, climate change impacts hit severely poorer countries and weaker social groups within a country due to their higher exposure, sensitivity and lower adaptive capacity, exacerbating negative processes already ongoing (e.g. desertification, water scarcity, access to clean water, increase in mortality and morbidity of climate related diseases). On the other hand, policy themselves originate distributional effects and concerns. At international level, climate change policies are “cursed” by the global public good nature associated to the externality of a “clean atmosphere”. Accordingly, to be effective mitigation needs to involve a large number of countries (or major emitters). However, being non excludable, the benefit from any mitigation policy by a country or group originates a free riding incentive, meaning that some countries may prefer not to engage in mitigation efforts, enjoying the environmental benefit produced by the abating coalition (“leakage effect”). The leakage effect refers to cheaper production of goods and services in “non abating countries” with weaker environmental regulation that attract production and demand at the expense of “abating countries” with a loss of competitiveness, production and market share of the latter. This competitiveness loss concerns primarily strategic sectors like energy production or energy intensive sectors. The leakage effect also refers to the increase in emissions in the non abating countries. Consolidated evidence places the emission leakage between the 5 % and 40 % of abatement efforts.

Large international environmental agreements, which are necessary for environmental effectiveness, are very unlikely to occur, especially if they devise substantial abatement efforts for participants. Moreover, lower abatement efforts are available in the developing countries, which historically carry less responsibility for climate change effects and are less capable of adaptation.

Finally, climate change policies are also of difficult domestic acceptability as they imply increasing energy prices and exert potentially regressive effects on households, worsen energy access of poorer groups and spur inflationary pressures.

Carbon-energy efficiency and the reduction of the environmental externalities from emissions in Sweden have been pursued with a complex mix of economic (taxes, cap and trade) and regulatory instruments addressing the supply and demand side of the economic system[i]. Sweden excise duty on energy is based onto two components: an energy tax and a CO_2 tax.

Regarding energy taxation, Sweden implemented a **tax on petrol and diesel** in 1924, an **electricity tax** in the 1950s, an **oil and coal tax** in 1957, an **LPG tax** in 1964, a **natural gas** tax in 1985 and a sulphur tax in 1991. The level of **energy tax** varies between different fuels and includes various forms of exemptions. The energy tax rate has changed over time and peaked in 1990, reaching 960 SEK (€103.96)/m3 on oil and 460 SEK (€49.62)/tonne on coal (Speck et al. 2006).[1] The Swedish energy tax system was reformed in 1991 to be based on a carbon tax and an energy tax on fuels (not connected to the carbon content), under which industry was exempted from the energy tax and subject only to 50 % of the carbon tax. In 1993, this fraction was reduced further to 25 %, and in 1997 raised back to 50 %. In 2009 energy tax on natural gas was SEK 0.024/kWh, on coal SEK 0.045/kWh and on heating oil SEK 0.08/kWh. Energy tax on petrol (environmental class 1) is SEK 0.341/kWh and energy tax on diesel (environmental class 1) is SEK 0.134/kWh. However, biofuels for burning and vehicles and manufacturing industry and fuels for heating production in co-generation plants were not covered. The 2009 climate policy resolution restructured the energy tax: from 2011 onwards, the level of tax is set on the basis of the energy content of the fossil fuel at SEK 0.08/kWh on fuels for households, services and district heating. Fossil fuels used for heating in industry, heating production in CHP plants and in land-based industries are also covered by energy tax.

In 1991, Sweden was one of the first countries to introduce a **carbon tax**. At that time, the tax was supposed to cover all sectors, although it was high for households and services in comparison with sectors subject to international competition and carbon leakage (industry, agriculture and heat production in combined heat and power plants (CHP)). The idea was then to progressively increase the tax rate and fine tune to ensure a cost effective taxation (Åkerfeldt 2011).[2] With the introduction of the EU ETS in 2005, sectors that were covered by the carbon tax also had to face the EU ETS carbon price[ii]. Therefore, to avoid double regulation, the government decided to exempt the industries covered by the EU ETS from the carbon tax, for example the manufacturing industry (outside the EU ETS), agriculture, forestry and aquaculture pay 21 % of the general level of tax for fuel used for heating. There are however special rules for further tax relief for energy-intensive industries, for diesel used in land-based industries and for fuel used in combined heat and power plants. According to the 2009 parliamentary climate policy resolution, carbon dioxide tax on fossil fuels for heating in

[i] There are as well voluntary agreements and information/awareness raising activities as part of the strategy (see Table 2), but these are not considered, as the focus of the analysis is on the cost effectiveness of market based and regulatory instruments.

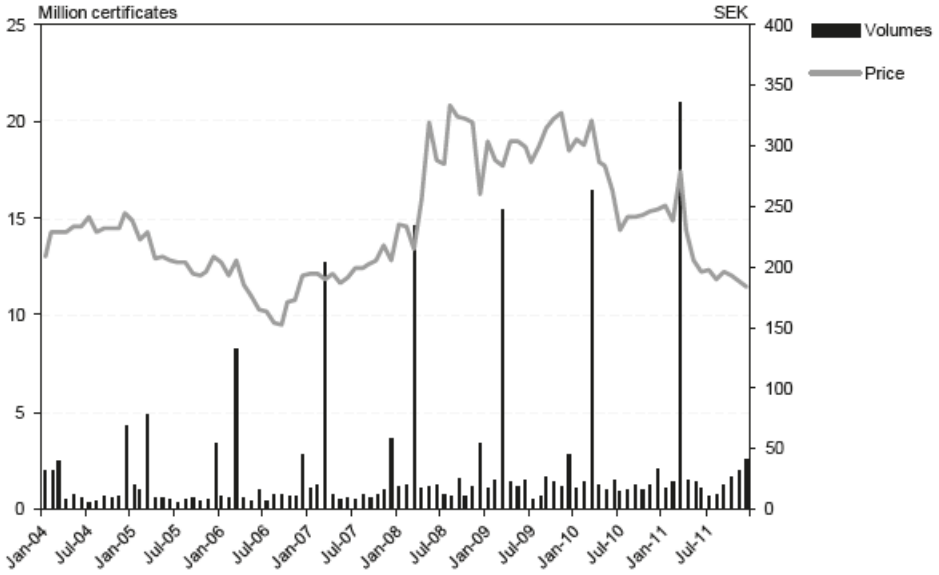
[ii] The EU ETS covers installations in the production of electricity and in the heating sector, refineries, installations that produce and process iron, steel, glass and glass fiber, cement and ceramics and installations that produce paper and pulp. Most emissions from the transport sector and from households are excluded.

the industry outside EU ETS and for agricultural, forestry and water activities is to be raised from 21 % to 60 % of the general level by 2015 with a first step of 30 % by 2011. The special rule on tax relief for energy intensive industry is also to be removed in stages over the same period.

Since 2006, Sweden has a **CO2-based vehicle tax**. Since 2011, light-duty vehicles, buses and motor caravans are covered by a CO2 factor and heavy-duty vehicles and trailers continue to be subject to the vehicle tax according to weight and exhaust levels, having to pay an annual toll charge. There are a number of motor vehicle tax breaks for so-called "environment friendly" new passenger vehicles, which are exempted from vehicle tax for the first five years since 2009. Since 2012, a rebate of up to SEK 40 000 (EUR 4 600) has been granted to purchasers of vehicles that emit 50 g CO2 per km or less ("super environment-friendly cars").

In addition to fuel, energy and carbon taxes, Sweden has in place a wider set of instruments working for the improvement of carbon and energy efficiency. Among these, the electricity **certificate system, introduced in 2003** and the replacement of investment state aid for fossil free electricity production, mainly bio fuel CHP plants, are the main instruments used to increase the supply of electricity from renewable and to meet the 2020 targets. Under the electricity **certificate** system, binding since 2005, electricity producers (and some users) are required to purchase certificates equivalent to a certain proportion (quota) of their sales (or use), creating a demand for certificates. Producers of electricity from renewable energy sources receive an electricity certificate for every megawatt-hour of electricity produced, creating a supply for certificates. The price of the certificates depends on supply and demand and, in turn, on the size of the quota obligation, which is adjusted every year by the government to generate an increasing demand for certificates (see Figure 1). Exemptions from quota obligation are foreseen for smaller producers of renewable electricity who use the electricity they produce and for electricity-intensive industries to maintain competitiveness. In 2007 electricity users were obliged to purchase electricity certificates corresponding to 15.1 % of their electricity use. On 1 July 2010, Sweden's Parliament approved the government's proposal to amend the Electricity Certificates Act, leading to increased quotas in order to meet the share of 50 % renewable energy by 2020, associated to a higher target for the electricity certificate system corresponding to a 25 TWh increase compared to 2002. At the same time, Sweden extended the system until the end of 2035. In 2011 Sweden and Norway signed a legally binding treaty on a common market for electricity certificates which started in 2012 and will last until 2036.

Figure 1: Volume-weighted average monthly price of Swedish electricity certificates and number of certificates traded per month, 2004-2011



Source: International Energy Agency. 2013. "Energy Policies of IEA Countries: Sweden 2013 Review." OECD/IEA Paris

The main **regulatory tools** are the **building regulation standards for energy efficiency** used in Sweden since the 1960s, whose tightening of the requirements came into effect on 1 February 2009 and again in 2012. The **fluorinated greenhouse gases (F-gases) regulation** was applied in Sweden following the EU Regulation (No 842/2006) on Certain Fluorinated Greenhouse Gases and in 2007 emissions of F-gases totalled around 1.3 million tonnes of carbon dioxide equivalent. It is estimated that, because of the regulation, these emissions altogether will decrease to around 0.4 million tonnes/year in 2020. Regulatory instruments also prevail in the land use, land use change, forestry activities andmanagement of municipal waste and landfilling.

The policy response needs to be:

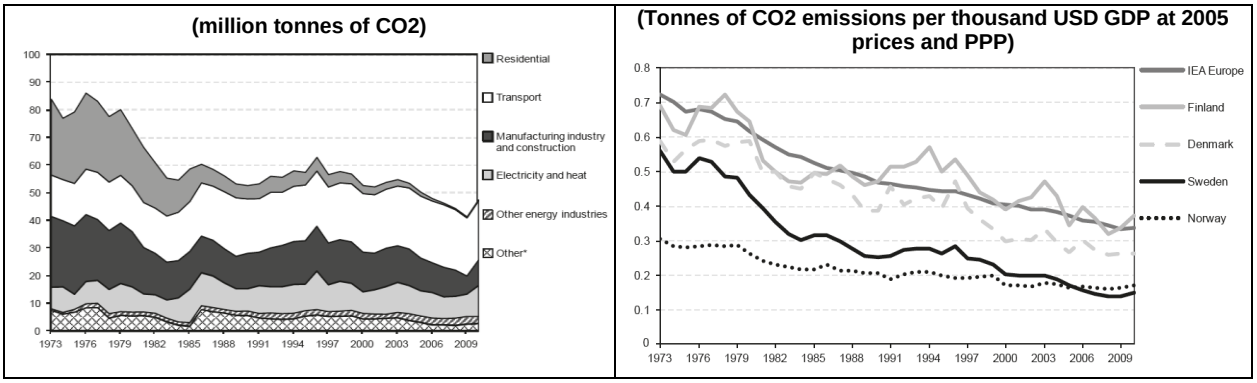
- Effective i.e. able to reach the devised target (specifically Sweden's 2020 and 2050 energy efficiency and environmental goals, see section 6).While in terms of energy efficiency, the policy effectiveness can be assessed at a domestic level, when emissions are considered, it is important to take into account the trans-boundary (leakage) effects, designing domestic policies as part of a wider and coordinated international effort to avoid counterproductive effects outside the country.
- Efficient i.e. the policy should accomplish its goal at the lowest possible economic cost for the society, allocating either the abatement or energy efficiency improvement efforts where and when it is cheaper. Basically this would call for a widespread involvement of many sectors and for the use of market based instruments (taxes and/or cap and trade systems) over regulation.
- Equitable i.e. the policy cost should be shared in an acceptable manner. Equity has an international dimension involving sharing burdens across countries with a sectoral characterization. Concerns related to adverse international competitiveness effects for energy intensive sectors are part of the problem with Equity having an intra-national dimension pertaining to potential regressive effects of carbon and energy taxes.

3.3 Historical performance and projections into the future: Insights on decoupling

What has been the trend vs. GDP (or other economic performance metrics, such as sectoral growth) and what type of decoupling has been achieved?

Since 1990, Sweden has decreased its emissions annually by 0.5 % on average. CO_2 emissions from fuel combustion were 9.8 % lower in 2010 than in 1990 (Figure 2 left). In 2010, they represented 75 % of all GHG emissions, amounting to 47.6 million tonnes (Mt). Sweden lowered its carbon intensity by 40.5 % in 2010 compared with 1990 (Figure 2 right). In 2010, it recorded 0.15 kg of CO2 emissions per unit of GDP at PPP and ranked as the second-lowest among IEA members. This is mainly because Sweden has a high share of renewable energy sources and nuclear in Total Primary Energy Supply (TPES) (35.5 % and 32.5 % respectively in 2011).

Figure 2: Swedish CO_2 emissions by sector and energy-related CO_2 emissions per GDP in Sweden and other selected IEA member countries, 1973-2010



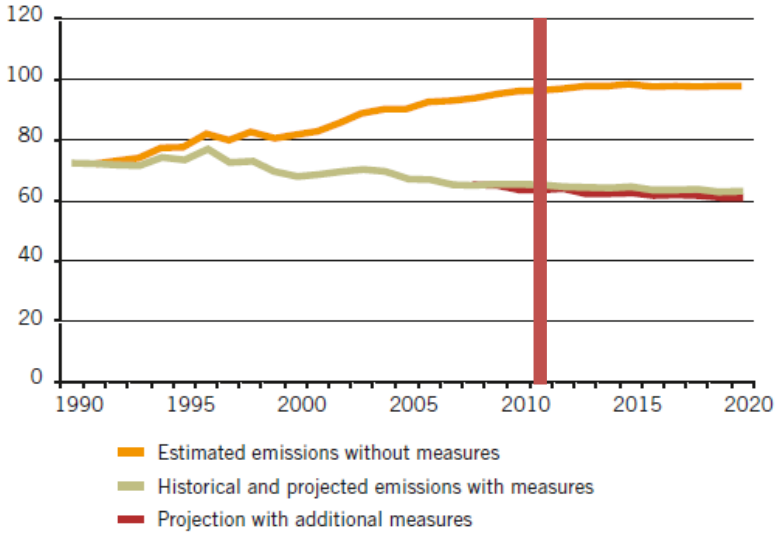
Source: International Energy Agency. 2013. "Energy Policies of IEA Countries: Sweden 2013 Review". OECD/IEA Paris

Between 1990 and 2011 Sweden's total GHG emissions declined by 15 % (Figure 3), and the average 2008–2011 emissions were already 12.6 % lower than 1990 level, thus well below both the burden-sharing target of 4 % and the national more stringent voluntary commitment of the -4 % compared with 1990 for the period 2008–2012.

As a consequence of existing and additional measures decided within the framework of Sweden's climate change and energy policies (see Section 6 below), this trend should continue also up to 2050, especially during the 2010-2020 period, as shown by the 2009 Sweden's Fifth National Communication to the UNFCCC and the more recent EEA report (2012) (see Figure 3).

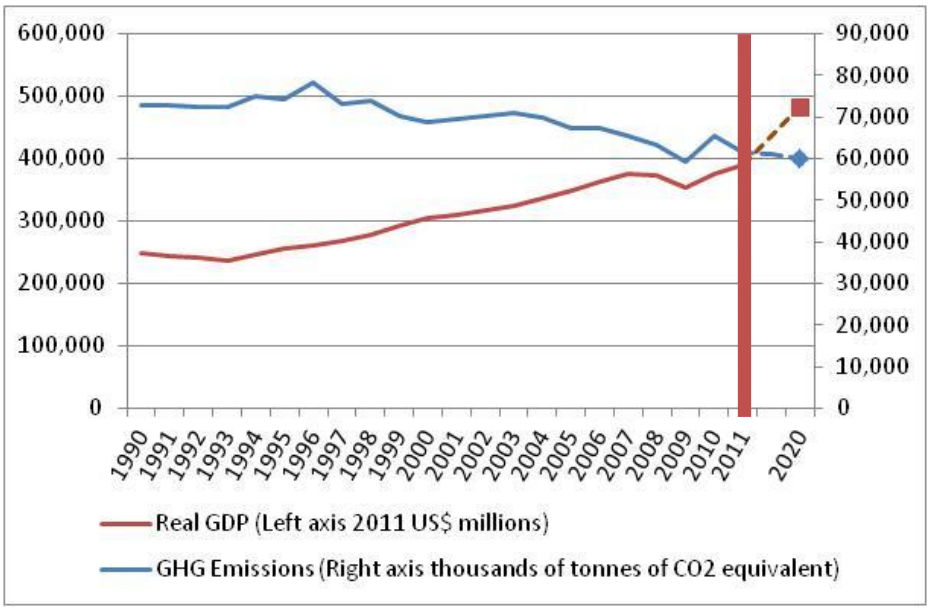
Between 1990 and 2010 Sweden's real GDP increased 57 % and, according to the 2012 Ageing Report, it is expected to increase by roughly 23 % in the 2010-2020 period. By compounding this information with GHG emission trends, this implies absolute decoupling during the period 1990-2010 that should strengthen from 2010 to 2020 (Figure 4).

Figure 3: Total Swedish GHG emissions trends and projections, 1990-2020 (million tonnes carbon dioxide equivalent)



Source: Swedish Ministry of the Environment. 2009. "Sweden's Fifth National Communication on Climate Change to the UNFCC". Stockholm

Figure 4: Historical and projected Swedish real GDP and GHG emissions, 1990-2020

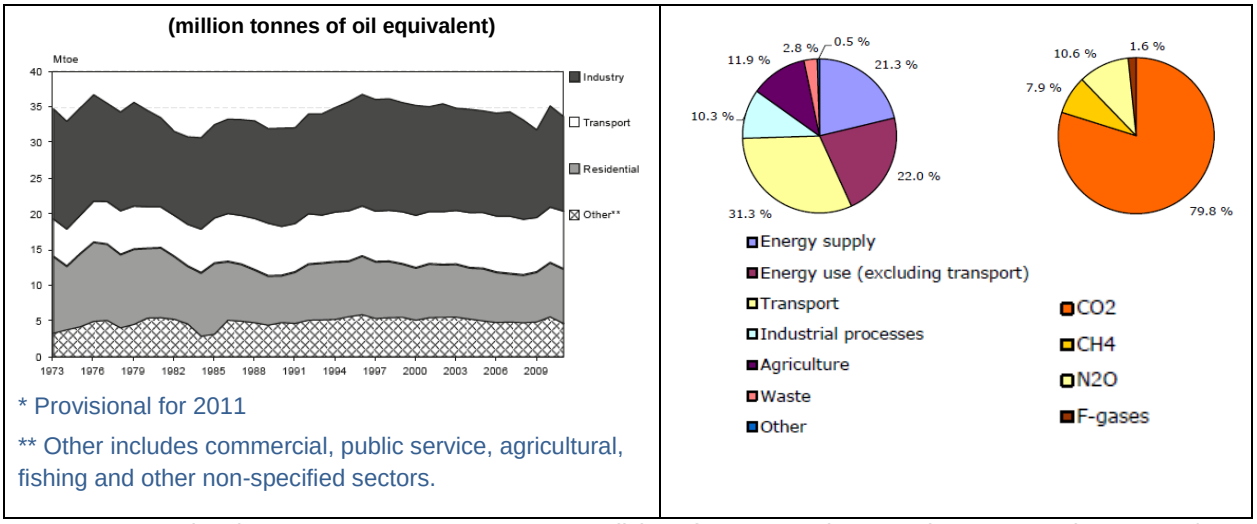


Source: our elaboration from: Eurostat (http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database) on 1990-2010 GHG emissions and on 1990-2010 Real GDP; European Environment Agency. 2012. *Greenhouse gas emission trends and projections in Europe 2012 - Tracking progress towards Kyoto and 2020 targets*. EEA Report No 6/2012 on 2010-2020 GHG emissions; European Commission. 2011. *The 2012 Ageing Report. Underlying Assumptions and Projection Methodologies*. European Economy 4/2011 on 2010-2020 GDP projections

4 Drivers affecting change: resource use/ environmental issues

What are the drivers affecting resource use (driving demand for the resource and leading to resource overuse) or other environmental impacts?

Figure 5: Sweden's total final energy consumption by sector (1973-2011) and GHG emissions by main source and gas in 2010



Source: International Energy Agency. 2013. Energy *Policies of IEA Countries: Sweden 2013 Review*. OECD/IEA Paris, European Environment Agency. 2012. *Greenhouse gas emission trends and projections in Europe 2012 - Tracking progress towards Kyoto and 2020 targets*. EEA Report No 6/2012

Table 1: Decomposition of GHG emissions in Sweden and selected EU countries, 2010

	GHG/Pop (Tons of CO2 eq. per capita)	GDP/Pop (Current prices at Purchasing Power Standards per capita)	Energy/GDP (kilogram of oil eq. per 1000 Euros)	GHG/Energy (tons of CO2 eq. per ton of oil eq.)
EU27	9.4	24502	152.1	2.86
Sweden	7.0	30353	159.4	1.33
France	8.0	26552	151.6	2.00
Germany	11.5	28991	141.9	3.08
Italy	8.3	24771	123.6	3.01
UK	9.6	27646	111.9	2.90

Source: Our elaboration on EUROSTAT data (http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database)

In 2010, the main generator of GHG emissions in Sweden was the transportation sector, followed by energy consumption and supply processes which together built up roughly 74 % of the total GHG emissions (What are *the drivers affecting resource use (driving demand for the resource and leading to resource overuse) or other environmental impacts?*

Figure 5 right). The main energy users were industry, the transportation and the residential sectors (see What are *the drivers affecting resource use (driving demand for the resource and leading to resource overuse) or other environmental impacts?*

Figure 5 left and for more detail section 5 below).

Table 1 highlights that Sweden has relatively low emissions per capita compared to other EU countries as well as a low carbon intensity in the energy mix. This mainly reflects the development of nuclear energy over the past four decades (40.5 % of electricity generation in 2011) and the more recent development of energy from renewable sources, mainly electricity from hydroelectric power generation and biofuels imports. At the same time, the country shows a higher energy intensity of GDP. This is mainly due to Sweden's very energy-intensive industry and high domestic energy consumption due to the cold climate.

According to the latest long-term projections of the Swedish Energy Agency (International Energy Agency 2013),[3] total final energy consumption in Sweden will increase by 10.4 % to 37.2 Mtoe in 2020, with most of the increase expected to come from the industry sector. Consumption growth will slow to 1.8 % to 2030, reaching 37.9 Mtoe. This reference scenario assumes that new nuclear will replace existing reactors after 60 years of operation. Industry consumption is expected to increase by 28.5 % up to 2030, as the economic recovery was faster than expected, thus fostering Swedish industrial growth, but also electricity and coal use in the iron and steel and pulp and paper industries. Industry consumption will grow by 24.2 % by 2020, and a further 3.5 % in the years to 2030.

This increase in energy consumption in the industry sector is expected to be compensated by lower consumption in the commercial sector, in particular thanks to expected energy efficiency gains in buildings. Residential energy consumption will grow at a slower rate of 9.1 % to 2030, while transport usage will remain relatively constant, growing by a mere 0.5 % over the nineteen years. The transport, commercial and residential sectors are expected to experience much slower growth in consumption compared to industry mainly due to an increase of renewable energy usage, including biodiesel (rapeseed-oil methyl ester or FAME), hydro-treated vegetable oils (HVO) and biogas. Sweden considers that it can reach its 2020 10 % renewable energy target in the transport sector already in 2015. In the residential sector, the increased use of heat pumps could largely replace existing electric heating. Energy use in the transport sector is projected to fall slightly to 2020, with a recovery in the ten years to 2030.

Energy supply from biofuels and waste is expected to steadily increase from 22.7 % in 2011 to around 25.3 % of TPES in 2030, after which strong growth is expected to come from wind power. Electricity generation in Sweden is expected to total 175 terawatt-hours (TWh) with electricity exports of 24 TWh in 2020 and 23 TWh in 2030 if electricity generation, additions coming from nuclear, combined heat and power (CHP) and wind power increase as well and only if a moderate increase in electricity use reaches 152 TWh.

5 Situation/trend prior to introduction of policy mix

Information on the baseline situation before the policy mix was introduced.

Energy supply

In 2011 Sweden's total primary energy supply (TPES) amounted to 48.9 million tonnes of oil equivalent (Mtoe), a level which has remained fairly stable over the last three decades with a sharp drop in 2009 amid the global financial and economic crisis. Fossil fuels, oil, coal and natural gas represented 31.8 % of TPES in 2011, making Sweden the IEA country with the lowest share of fossil fuels in its energy mix (without accounting for nuclear). Nuclear contributes largely to the Swedish electricity mix, accounting for 15.9 Mtoe or 40.5 % of its electricity generation in 2011. The share of renewable energy in TPES, reached 35 % in 2011.

Energy demand

Around 15 Mtoe of TPES was used in transformation in 2011, implying that total final energy consumption (TFC) was 33.7 Mtoe in 2011. The industry sector consumed the largest share of energy, accounting for 13.3 Mtoe or 39.3 % of the country's final consumption, followed by transport (24.1 %), the residential sector (22.5 %), and commercial, public services and agriculture sectors (14.1 %).

Emissions

In 2010 Sweden's GHG emissions accounted for nearly 60 MT CO2eq (Figure 2). The main generator of GHG emissions in Sweden was the transportation sector, followed by energy consumption and supply processes, which together built up roughly 74 % (What are *the drivers affecting resource use (driving demand for the resource and leading to resource overuse) or other environmental impacts?*

Figure 5 right).

6 Description of policy mix(es)

This section presents the main policy mix that will be the focus of this ex-post assessment.

Lifecycle focus (point of application(s) of the policy mix):	Production and consumption
Sector(s) covered:	Almost all sectors
Scale of application of policy mix:	Local, national, supranational, international.
Implementing body:	See

Table 2

Objective of policy mix:

The policy mix was developed within two Government bills (2008/09: 162 and 163) defining Sweden's targets for 2020 climate change policy, including targets for 2020.

As an EU member, Sweden has to contribute to the achievement of **EU targets** for 2020. The country targets are:

- A decrease in emissions of sectors outside the EU ETS by 17 % between 2005 and 2020. This is the consequence for Sweden of the Effort Sharing Decision under which Member States have agreed to a binding national emissions limitation target for 2020 for uncovered sectors reflecting each Member State's relative wealth.
- An increase in the share of energy from renewable energy sources from 40 % in 2005 to 49 % in 2020.

In addition to these EU targets, Sweden has also adopted three **national targets** (Government bills 2008/09:162 and 163):

- 40 % reduction relative to 1992 in GHG emissions for sectors not covered by the EU ETS (transport, housing, waste facilities, agriculture, forestry, aquaculture and some parts of industry). One third of the target is to be achieved through investments in other EU countries or in flexible mechanisms such as the CDM. The remaining two-thirds will have to be achieved in Sweden, corresponding to a decrease of GHG emissions by around 30 % in Sweden over 1990-2020.
- At least 50 % renewable energy, which is slightly above the EU target.
- 20 % reduction in energy intensity by 2020 relative to 2008.

Under the Kyoto protocol, Sweden had to limit its GHG emissions to no more than 4 % above 1990 levels for 2008-12. However, Sweden also adopted a more stringent target for the same period, which was to reduce the average level of emissions over 2008-12 by 4 % from the 1990 level. The target had to be achieved without resorting to carbon sinks or flexible mechanisms such as the Clean Development Mechanism (CDM), even though the latter is allowed under the Kyoto protocol.

However, Sweden is also discussing some longer term priorities:

- Phasing out fossil fuels in heating by 2020;
- Having a vehicle stock independent of fossil fuels by 2030;
- Developing a third pillar in electricity supply, next to hydro and nuclear power, with increased co-generation, wind and other renewable power production to reduce vulnerability and increase security of electricity supply;
- Reaching a sustainable and resource-efficient energy supply with zero net emissions of GHGs by 2050.

The 2050 target is part of the Sweden's Climate Roadmap 2050 presented on 11 December 2012, by the Swedish Environmental Protection Agency in collaboration with the Swedish Energy Agency and other national authorities to the Swedish government.

6a. Supplementary context questions including elements pertinent to paradigm discussions in DYNAMIX

Timeline for the different phases of the policy cycle (i.e. rationale and objective-setting; appraisal; implementation and monitoring).

Description of the government in power during each of the three following policy phases: rationale and objective-setting; appraisal; and implementation and monitoring.

Does the mix contain policies that are unusual or not typical of the country/ies or regional/local administration that implemented it?

Names of resource efficiency concepts, terms, models, ranking/classification systems, accounting methods etc. used or relied upon in each of the three phases of the policy cycle: rationale and objective-setting; appraisal; and implementation and monitoring, and how they were used (e.g.: 'waste hierarchy' – used in objective-setting to link policy objectives to more desirable uses for waste).

The roadmap is to be adopted in the course of 2013. From 2005 to 2009, the objective setting and appraisal phase takes place. We assume that the objectives for 2020 (and later) have been discussed after the entry into force of the Kyoto Protocol and defined with the two Government bills 2008/09:162 and 163 setting Sweden's targets for 2020. From 2009 to 2020, the implementation and monitoring phase takes place.

In 2005 with the entry into force of the Kyoto Protocol Sweden's Prime minister was Mr. Goran Persson (Social Democrats). The policy mix discussed is the one developed within the two Government bills 2008/09:162 and 163 defining Sweden's targets for 2020 climate change policy. At the time, Sweden's Prime Minister was Mr. Fredrik Reinfeldt, from the Moderate Party (Alliance for Sweden) elected in 2006 and currently in office. Four Member States rotated to hold the Presidency of the Council of the EU during those years: Slovenia (Jan-Jul 2008), France (Aug-Dec 2008), Czech Republic (Jan-Jul 2009) and Sweden (Aug-Dec 2009)

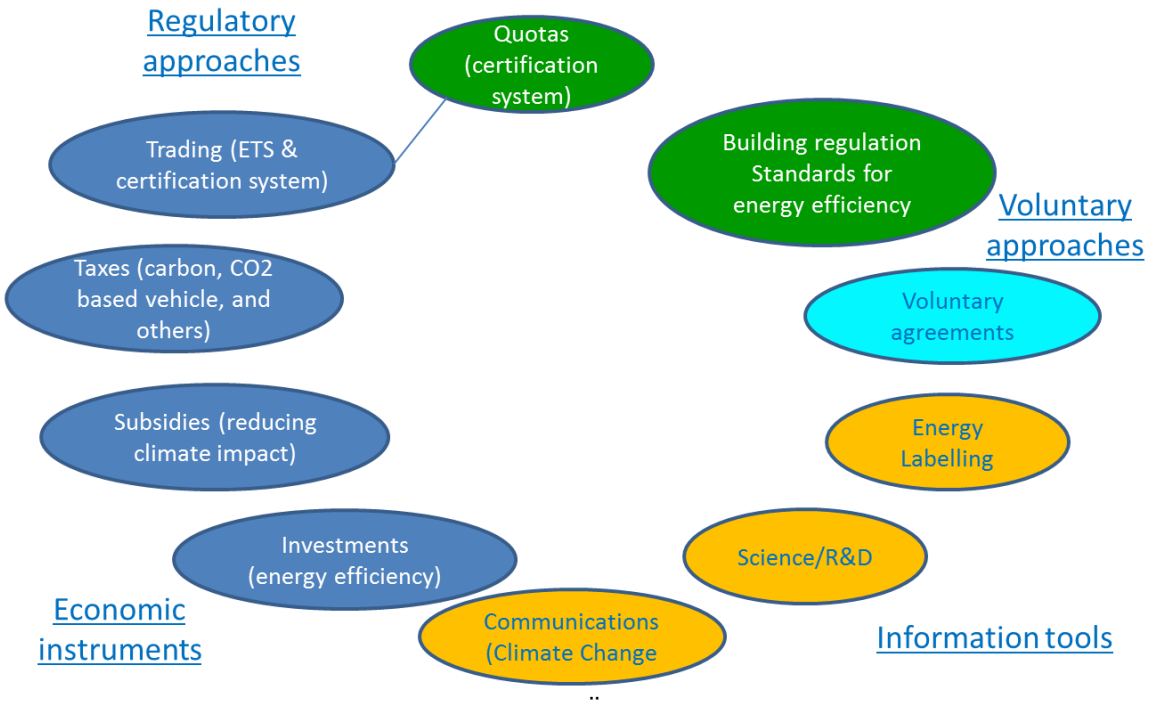
The policy mix does not contain **policies that are unusual or not typical** of the country/ies or regional/local administration that implemented it. The concepts of energy efficiency and security and zero carbon were used in all the three phases of the policy cycle (rationale and objective-setting; appraisal; and implementation and monitoring).

6b. Instruments and orientation of policy mix

Instruments in the mix and whether one type of tool (i.e. regulatory, economic, information) is dominant.

For each instrument, what is its aim? What requirements does it place on relevant players (for example, phasing out a certain substance, meeting minimum recycling targets, etc.)? What reporting requirements exist?

Figure 6: Toolkit of policy instruments and their relationships



Source: Own compilation

Table 2: Summary of Sweden's instruments for climate change and energy efficiency

Name of measure/ instrument	Primary purpose	Greenhouse gas primarily concerned	Type of instrument	Status of instrument	Administering government agency 2005	Estimated reduction in million tonnes CO_2e per year compared with 1990 (N.E. = not estimated) 2005	2010	2015	2020
Cross-sectoral instruments									
Local investment programme (LIP)	Change-over to ecological sustainability at local level	All	Economic	Concluded (1998-2008)	Swedish Environmental Protection Agency	Up to 1	Up to 1	Up to 1	Up to 1
Climate investment programme (KLIMP)	Subsidies for projects that reduce climate impact	All	Economic	Concluded (2003-2008)	Swedish Environmental Protection Agency	Up to 0.5	Up to 0.8	Up to 1	Up to 1
Delegation for Sustainable Cities	Change-over to ecological sustainability at local level	All	Economic	Ongoing (2009-	National Board of Housing, Building and Planning	N.E.	N.E.	N.E.	N.E.
Environmental Code	Ecologically sustainable development	All	Legislation	Ongoing (1999-	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.
Climate information campaign	Increased knowledge of problem of climate change	All	Information	Concluded (2002-2003)	Swedish Environmental Protection Agency	N.E.	N.E.	N.E.	N.E.
Research and development	Development of technology with very low climate impact	All	Economic	Ongoing 1990-	Swedish Energy Agency (principally)	N.E.	N.E.	N.E.	N.E.
Production of electricity and district heating									
Energy tax	Improve efficiency of energy use	Carbon dioxide	Economic	Ongoing (57-	Swedish Tax Agency	13	16	17	16
Carbon dioxide tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (91-	Swedish Tax Agency				
The electricity certificate system	Increase supply of electricity from renewable forms of energy	Carbon dioxide	Economic	Ongoing (2003-	Swedish Energy Agency and Svenska Kraftnät				
EUEmissions Trading Scheme	Reduce use of fossil fuels in the trading sector	Carbon dioxide	Economic	Ongoing (2005-	Swedish EPA and Swedish Energy Agency				
Residential and service sector									
Energy and carbon dioxide taxes	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing	Swedish Tax Agency	Up to 7	Up to 8	Up to 8	Up to 9
Building regulations - standards for energy efficiency	More efficient energy use	Carbon dioxide	Legislation	Ongoing	National Board of Housing, Building and Planning	N.E.	N.E.	N.E.	N.E.
Energy declarations	More efficient energy use	Carbon dioxide	Information on legislation	Ongoing (2009-	National Board of Housing, Building and Planning	N.E.	N.E.	N.E.	N.E.
Technology procurement	More efficient energy use and increased use of renewable energy	Carbon dioxide	Economic	Ongoing	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Mandatory energy labelling	More efficient energy use	Carbon dioxide	Information	Ongoing	Swedish Energy Agency	N.E.	N.E.	N.E.	N.E.
Investment aid for replacement of heating systems and energy efficiency measures	More efficient energy use and increased use of renewable energy	Carbon dioxide	Economic	Completed	National Board of Housing, Building and Planning County administrative boards	N.E.	N.E.	N.E.	N.E.
Industrial emissions from combustion and processes (including emissions of fluorinated greenhouse gases)									
Energy tax	Economic	Carbon dioxide	Economic	Ongoing (57-	Swedish Tax Agency	-	-	-	-
Carbon dioxide tax	Reduce use of fossil fuels	Carbon dioxide	Economic	Ongoing (91-	Swedish Tax Agency				
The electricity certificate system	Increase supply of electricity from renewable forms of energy	Carbon dioxide	Economic	Ongoing (2003-	Swedish Energy Agency and Svenska Kraftnät				
EU Emissions Trading Scheme	Reduce use of fossil fuels in the trading sector	Carbon dioxide	Economic	Ongoing (2005-	Swedish EPA and Swedish Energy Agency				

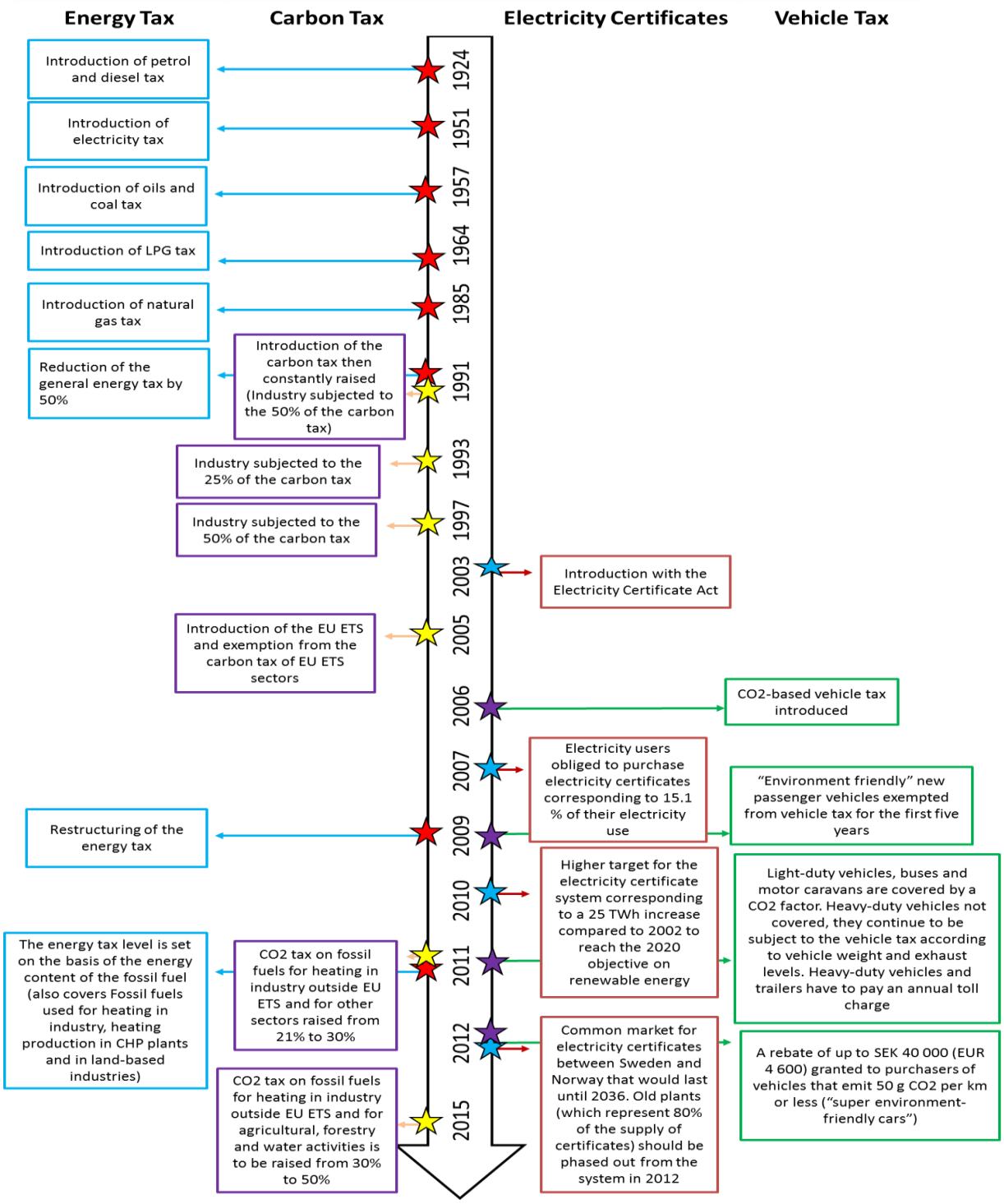
Name of measure/ instrument	Primary purpose	Greenhouse gas primarily concerned	Type of instrument	Status of instrument	Administering government agency 2005	Estimated reduction in million tonnes CO_2e per year compared with 1990 (N.E. = not estimated) 2005	2010	2015	2020
Proposals for reduced lowering of carbon dioxide tax for industry outside the EU Emissions Trading Scheme and for the introduction of energy tax on fossil fuels for heating in industry	Reduce use of fossil fuels	Carbon dioxide	Economic	Planned (with start 2011-2015)	Swedish Tax Agency	-	-	0.4	0.4
Programme for energy efficiency improvement	Reduce electricity use	Carbon dioxide	Voluntary/ negotiated agreement	Ongoing (2005-	Swedish Energy Agency	E.B.	E.B.	E.B.	E.B.
F-gas regulation including mobile air conditioners directive		HFCs	Legislation	Ongoing		0	0.2	0.5	0.7
Transport									
Vehicle-fuel taxes	Internalise the external effects of road transport including greenhouse gas emissions	Carbon dioxide	Economic	Ongoing	Swedish Tax Agency	1.7	1.9	2.3	2.4
Proposal for raised energy tax on diesel	Internalise the external effects of road transport including greenhouse gas emissions	Carbon dioxide	Economic	Planned 2011 and 2013	Swedish Tax Agency	-	-	0.1	0.2
Targeted instruments for introduction of renewable vehicle fuels	Increase use of renewable vehicle fuels	Carbon dioxide	Economic		Swedish Tax Agency (mainly)	0.6	1.8	2.6	3
Area of waste									
Rules on municipal waste planning, rules on producer responsibility for certain goods, tax on landfilling of waste (2000), prohibition of landfilling of non-separated combustible waste (2002) and prohibition of landfilling organic waste (2005)	Increase recycling of waste and reduce total waste quantities	Methane gas	Legislation and fiscal instruments	Ongoing	Swedish Environmental Protection Agency	0.8	1.4	1.7	1.9
Agriculture									
Targeted environmental grants under rural development programme	Reduced Climate Impact, A Varied Agricultural Landscape and Zero Eutrophication	Nitrous oxide and methane	Economic	Ongoing	Swedish Board of Agriculture	N.E.	N.E.	N.E.	N.E.
Land use, land-use change and forestry (LULUCF)									
Provisions on forest stewardship etc. in the Forestry Act.	Attaining environmental objectives and production targets for forests	Carbon dioxide	Legislation	Ongoing	National Board of Forestry	N.E.	N.E.	N.E.	N.E.
Provisions on drainage in the Environmental Code.	Biodiversity	Carbon dioxide and methane	Legislation	Ongoing	County administrative boards	N.E.	N.E.	N.E.	N.E.
Provisions on nature reserves and habitat protection in the Environmental Code and nature conservation agreements	Biodiversity	Carbon dioxide	Legislation	Ongoing	Swedish EPA and county administrative boards	N.E.	N.E.	N.E.	N.E.
Voluntary set-asides, partly through voluntary forest certification systems (FSC and PEFC)	Environmentally sound forestry	Carbon dioxide	Voluntary/ negotiated agreement	Ongoing		N.E.	N.E.	N.E.	N.E.

Source: Swedish Ministry of the Environment. 2009. *Sweden's Fifth National Communication on Climate Change to the UNFCC*. Stockholm

6c. Evolution of policy mix

Evolution of the policy mix throughout its existence –details of the introduction of the first policy tool(s), then all subsequent relevant tools, and related revisions/reforms (e.g. progressive increases in rates applied through economic tools, broader extension of regulation requirements, etc.).

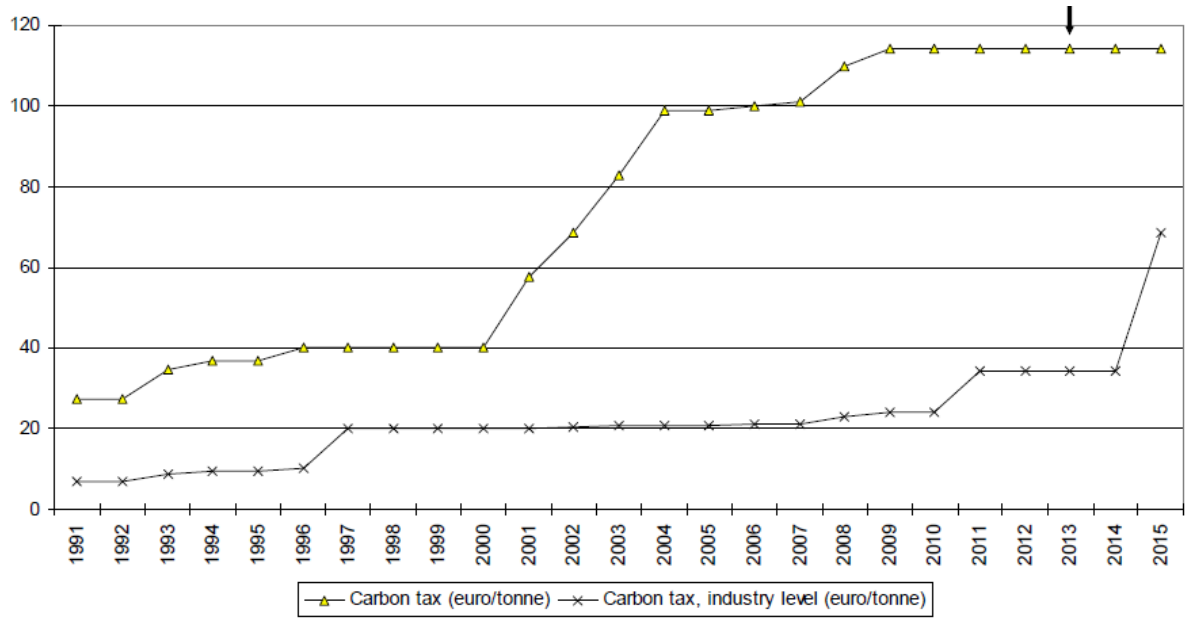
Figure 7 Evolution of Policy Mix



Source: Own Compilation

The past and, when available, next future evolution of the main components of the policy mix are summarised in Figure 8.

Figure 8: Development of the Swedish carbon dioxide tax (general and industry levels), 1991-2015



Source: Åkerfeldt, S. 2011. Swedish energy and CO2 taxes. National design within an EU framework. presented at the Conference on "Environmentally Related Taxes and Fiscal Reform" Ministry of Economy and Finance in collaboration with European Environment Agency Rome December 15, 2011

7 Evaluation of policy mix: effectiveness (environmental sustainability)

Does/did the policy mix result in a positive environmental outcome?

Were its stated objective(s) met? Were the instruments used sufficient to meet the objectives?

Did other, unforeseen/unintended positive outcomes or impacts (environmental, social, economic) result? Did other such negative outcomes or impacts result?

Were these objectives set at a level to meet environmental needs (e.g. avoid crossing environmental thresholds/tipping points or achieve more sustainable levels of resource use/extraction (e.g. maximum sustainable yield (MSY) in fisheries)?

Which sectors/actors were identified as having key impacts/influences on the problem/issue? (e.g. specific industrial/ business sectors, consumers, economy as a whole?) Did any of the instruments specifically target these key sectors/actors? Was there significant take-up/implementation of (voluntary) instruments by these sectors?

Was the policy mix applied to a sector previously not targeted by policies on the issue under question, or in a new area/issue – thereby aiming to stimulate change?

What were the anticipated and actual outcomes, impacts and effects of the policy mix on the behaviour of sectors and actors targeted? (e.g. reductions in emissions from industry, increased recycling rates, increase/decrease in certain product purchases, etc.).

Relationships between the instruments, identifying positive/negative influences on the overall policy mix or on key instruments in the mix, as well as any positive or negative impacts from changes to the mix (introduction or termination of instrument(s), increase or decrease in tax/levy/charge, etc.). Level of 'connectivity' (strong, weak) between each instrument and the primary one(s).

Are there any indicators, monitoring systems, review processes or other monitoring mechanisms in place to track progress?

It is not possible to access the environmental sustainability of the policy mix, given that the policy mix is expected to produce results by 2020. In 2010 Sweden has been able to over comply with its national emission reduction targets that were already stricter than those required by the Kyoto commitment. Sweden's Fifth National Communication to the UNFCC estimates that without the measures implemented since the beginning of the 1990s, the country's GHG emissions would have been roughly 37 % higher than observed in 2010 (see Figure 3).

The use of several policy instruments that interact in the area of climate change makes it difficult to assess the impact of each instrument and in particular of the carbon tax. However, the carbon tax is considered to have caused considerable emission reductions in the residential sector (district heating mostly) and it has mitigated the increasing trend in emissions in transport. Its impact on industry is probably small as this sector benefits from large exemptions.

The Fifth National Communication also estimates full correspondence of existing and planned measures with the 2020 targets. There are important connections between the different instruments, especially the national energy tax, the CO2 tax and the EU ETS introducing flexibility to meet the Kyoto and post Kyoto mitigation targets (i.e. the EU climate and energy package to 2020). For interactions across policy instruments see section 3.2 and section 8 below.

8 Evaluation of policy mix: efficiency (economic sustainability)

Is/was the policy mix considered cost-effective?

What has been the level of impact on resource use of the policy mix (the effect)?

What have been the costs of implementing the policy mix for target audience (e.g. business, households, etc.)?

What are the costs (financial, human) of implementing the policy mix for the implementing authority – i.e. the administrative/transaction costs?

Were sufficient resources made available to ensure an effective implementation of the policy-mix?

Was anything foreseen in the policy-mix to address competitiveness concerns (e.g. use of exemptions) or minimise transaction costs (e.g. thresholds below which monitoring wasn't required)?

Did the policy mix involve providing financial support (e.g. subsidies, low interest loans, tax breaks etc.) to key actors (e.g. sector, households, etc.)?

Did the measures generate revenues (e.g. in the case of taxes) and if so, was revenue recycled/re-injected into the economy, and to what levels and activities? Did revenue recycling have positive amplifying effects?

In synthesis - was the policy mix cost-effective?

What elements of the mix were (un)helpful in improving cost-effectiveness?

How was relative/absolute decoupling achieved?

Were resource limits or other thresholds taken into account and how were they addressed?

At the moment it is not possible to identify the level of impact on resource use of the policy mix, given that the policy mix is expected to produce results by 2020. On the impact of resource use of past Sweden's climate change and energy policy, please refer to sections 3.3 and partly 6b for details. In the last 20 years Sweden's GHG emissions declined 15 %, carbon intensity 40 % the share of renewable energy in total energy supply increased 40 %.

The costs are not available: both of implementation of the policy mix for the target audience (e.g. business, households, etc.) and of implementation of the policy mix for the implementing authority (financial, human) – i.e. the administrative/transaction costs. EC estimations conducted with the GEM E-3 CGE model (European Commission 2008)[4] report a potential cost for Sweden to meet its 20-20-20 targets of about the 0.3 % of GDP in 2020 compared to the baseline.

The carbon/energy efficiency package includes a complex system of exemptions and differentiated tariffs periodically revised targeted to industry and to sectors exposed to international competition (see section 3.2) to address competitiveness concerns and distributional issues.

The main tools of the policy mix are fiscal instruments (CO_2 and energy taxes) that generated a revenue in 2011 of almost SEK 87 billion, amounting to 2.5 % of Sweden's GDP and constituting 80 % of total environmental taxation revenues in the country (see Table 3 and Table 4).

Table 3: Swedish environmental tax revenues, 1993-2001 (SEK million at current prices)

	1993	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*
Total	**48,146**	**49,290**	**50,538**	**57,505**	**56,554**	**59,647**	**59,983**	**62,344**	**66,209**
Energy tax	**38,929**	**42,279**	**43,418**	**48,945**	**48,339**	**51,084**	**51,007**	**52,011**	**55,987**
Energy tax on fuels	20,524	22,781	23,509	25,505	26,217	26,829	26,664	27,032	23,858
Electricity taxes [1]	6,824	7,197	7,536	8,869	9,613	11,245	11,648	11,937	13,294
Hydroelectic power tax	1,029	800	933	1,520					-
Nuclear power tax (capacity) [2]								881	1,862
Carbon dioxide tax	10,552	11,501	11,440	13,051	12,509	13,011	12,695	12,162	16,973
Tax on certain substances	**992**	**962**	**1,110**	**1,510**	**1,295**	**1,331**	**1,315**	**2,349**	**2,236**
Sulphur tax	184	191	157	217	144	148	120	89	101
Tax on insecticides	13	22	32	35	52	55	40	58	59

Tax on commercial fertilizers	185	164	299	388	372	340	342	357	369
Tax on waste	-	-	-	-	-	-	-	1,085	899
Environmental protection fee [3]	77	64	60	135	62	71	87	116	119
Fee to the battery fund	-	-	61	92	61	132	164	133	123
NOx fee	533	521	501	643	604	585	562	511	566
Tax on transportation	**8,225**	**6,049**	**6,010**	**6,981**	**6,789**	**7,090**	**7,521**	**7,859**	**7,864**
Vehicle tax	4,095	4,064	4,049	5,471	6,242	6,103	6,396	6,847	7,014
Sales tax on motor vehicles	1,287	1,778	1,749	1,250	209	233	261	194	-22
Congestion tax									-
Kilometre tax	2,737	10							-
Fee to the vehicle scrap fund	106	197	212	260	338	224	264	253	226
Road charges				-	-	530	600	565	646
Tax on road traffic insurance				-	-	-	-	-	-
Tax on natural resources				**70**	**131**	**142**	**140**	**125**	**123**
Natural gravel tax				70	131	142	140	125	123
Env. taxes as % of GDP in Sweden	3.1%	2.9%	2.8%	3.1%	2.9%	2.9%	2.8%	2.8%	2.8%
Total energy tax rev. as % of tot. env. tax. rev.	80.9%	85.8%	85.9%	85.1%	85.5%	85.6%	85.0%	83.4%	84.6%
Energy tax. rev. as% of tot. env. tax. rev. (excluding carbon taxes)	58.9%	62.4%	63.3%	62.4%	63.4%	63.8%	63.9%	63.9%	58.9%
Carbon tax. rev. as % of tot. env. tax. rev.	21.9%	23.3%	22.6%	22.7%	22.1%	21.8%	21.2%	19.5%	25.6%

Source: our elaboration from Statistics Sweden http://www.scb.se/Pages/TableAndChart____39451.aspx

Table 4: Swedish environmental tax revenues, 2002-2011 (SEK million at current prices)

	2002	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010**	*2011**
Total	**70,349**	**73,063**	**75,106**	**78,965**	**80,626**	**82,834**	**86,826**	**87,973**	**90,253**	**86,861**
Energy tax	**59,552**	**61,983**	**63,810**	**65,580**	**66,615**	**67,634**	**69,068**	**70,423**	**72,538**	**69,862**
Energy tax on fuels	23,214	20,797	17,880	19,461	19,276	19,457	19,590	20,224	20,146	20,414
Electricity taxes [1]	14,619	16,116	17,578	18,640	19,396	19,812	19,732	20,720	21,061	20,227
Hydroelectic power tax	-	-	-	-	-	-	-	-	-	-
Nuclear power tax (capacity) [2]	1,789	1,829	1,863	1,794	3,198	3,238	3,976	3,395	3,997	3,852
Carbon dioxide tax	19,930	23,241	26,490	25,685	24,745	25,127	25,770	26,084	27,334	25,369
Tax on certain substances	**2,281**	**2,290**	**2,036**	**1,943**	**1,758**	**1,697**	**1,457**	**1,165**	**1,162**	**1,120**
Sulphur tax	156	199	131	121	81	56	58	39	48	28
Tax on insecticides	44	67	61	77	81	81	89	72	86	86
Tax on commercial fertilizers	356	340	303	329	295	306	366	178	-	-
Tax on waste	906	892	729	735	646	608	332	189	289	204
Environmental protection fee [3]	109	109	108	-	-	-	-	-	-	-
Fee to the battery fund	121	101	84	93	85	78	76	14	25	8
NOx fee	589	582	620	588	570	568	536	673	714	794
Tax on transportation	**8,399**	**8,596**	**9,058**	**11,242**	**11,999**	**13,242**	**16,047**	**16,219**	**16,400**	**15,716**
Vehicle tax	7,428	7,686	8,062	10,247	10,520	10,349	11,308	11,524	11,875	1,229
Sales tax on motor vehicles	15			2	2	3				

Congestion tax	-	-	-	-	489	345	687	785	799	801
Kilometre tax	-	-	-	-	-	-	-	-	-	-
Fee to the vehicle scrap fund	243	269	276	271	270	155	-	-	-	-
Road charges	713	641	720	722	718	748	782	891	778	779
Tax on road traffic insurance	-	-	-	-	-	1,642	3,270	3,019	2,948	2,907
Tax on natural resources	**117**	**193**	**202**	**200**	**254**	**261**	**254**	**166**	**153**	**163**
Natural gravel tax	117	193	202	200	254	261	254	166	153	163
Env. taxes as % of GDP in Sweden	2.9%	2.9%	2.8%	2.9%	2.7%	2.6%	2.7%	2.8%	2.7%	2.5%
Total energy tax rev. as % of tot. env. tax. rev.	84.7%	84.8%	85.0%	83.1%	82.6%	81.6%	79.5%	80.1%	80.4%	80.4%
Energy tax. rev. as% of tot. env. tax. rev. (excluding carbon taxes)	56.3%	53.0%	49.7%	50.5%	51.9%	51.3%	49.9%	50.4%	50.1%	51.2%
Carbon tax. rev. as % of tot. env. tax. rev.	28.3%	31.8%	35.3%	32.5%	30.7%	30.3%	29.7%	29.7%	30.3%	29.2%

Source: our elaboration from Statistics Sweden http://www.scb.se/Pages/TableAndChart____39451.aspx

Revenues are not earmarked. However, during the 2001–2006 period, Sweden experienced a first “green tax shift”, which moved 1.6 billion € of revenues raised by the environmental taxes to cuts in income taxes targeted to low incomes households via increased basic deduction. Between 2007 and 2010, environmental taxes were increased for households and firms, but labour taxes decreased (minus 8,6 billion Euro),with a view to increasing labour supply and employment. This strategy could be maintained in the future (Åkerfeldt 2011).[5]

Due to the prospective nature of the policy mix a precise assessment of its cost-effectiveness or economic efficiency is complex. Useful indications can be provided by the analysis of the past policies.

In a first-best world, the efficiency (cost minimizing property) of an instrument or group would be proven by the fact that the marginal costs of the policy (whether aiming to abatement or to improve energy efficiency) are equalized across all the different sectors subjected to the policy. This would imply to observe the same carbon price across all different sectors and, implicitly, higher abatement where it is cheaper. In the case of Sweden (as in all the EU countries) this is obviously not the case, partly due to the implementation design of the EU climate-energy policy. It sets differentiated emission reduction targets for different countries and macro-sectors, but allows trade only to a subgroup, preventing reaching the desired target at the minimum cost.

A further concern with efficiency derives from the many overlapping instruments and goals characterizing Sweden’s national policy mix (Jamet 2011).[6] As mentioned, the main instruments in place are the energy tax on fossil fuels and the CO_2 tax: both raise revenues and hit carbon emissions, directly or indirectly. The complex system of exemptions complicates the picture. Differentiated CO_2 taxation across fuels and sectors lowers the cost-effectiveness of the instrument because emission abatements are made in sectors (and for fossil fuels) where tax rates are highest and not necessarily where marginal abatement costs are the lowest. Finally, an energy tax that indirectly taxes CO2 emissions on top of the carbon tax makes the price signal on carbon less clear to firms and households.

Two broad issues in the electricity certificate system deserve a particular mention. The first is whether there is a need to support specific carbon-free technologies beyond the incentives generated by carbon pricing, as this seems to be the case with R&D on renewable technologies being partly a public good (non excludable spillovers to other firms), therefore the associated benefits are not entirely appropriated by firms sustaining the costs. The second is which the optimal instrument for this support is, with the certificate system being a market-based instruments and allowing producers to choose among several innovative technological options that have the lowest cost but, on the other hand, these systems have a number of shortcomings:

- Deadweight losses are large as a majority of the certificates (76 %) has been attributed to old and profitable plants that would have developed renewable electricity anyway. These old plants have also likely benefited from other forms of governmental support to ensure functioning, and consumers have in fact paid two times the cost of the development of electricity from renewables. In order to address this problem, the government has decided that old plants (which represent 80 % of the supply of certificates) should be phased out from the system in 2012.
- Although the government has published in advance the yearly quota for 2003-30, the price of certificates has been relatively volatile (Figure 1), which is likely to have been detrimental to investment, because of low liquidity due to the few number of participants on the supply and demand side who can affect the price. The system also generates some transaction costs that are estimated to represent on average around 6 % of the price of the certificate (Swedish Energy Agency 2008).[7]

9 Evaluation of policy mix: welfare (social sustainability)

What social impacts have you found associated with the policy mix? E.g. jobs created, reduced health impacts, distributional impacts etc.

Were social aspects included in an ex-ante impact assessment of the policy mix if one was undertaken? What were these?

Has monitoring of social impacts been included in implementation, to identify actual effects compared to anticipated ones?

Was the policy mix designed to not be socially regressive? What measures were undertaken to ensure this?

Were equity concerns addressed and, in case of re-structuring of the economy/sector, measures in the area of reskilling of the workforce foreseen?

What other public acceptability elements were addressed or considered?

This section provides an overview of the social impacts considered in EU Impact Assessment methodology.

Fostering investment in renewable creates jobs but has a potential negative employment effect on energy intensive sectors, though this is difficult to assess. Demand for labour is positively affected due to the revenue recycling through cut in labour taxes.

Carbon energy taxation has a potential regressive impact, possible inflationary pressures, as well as a gain through reduced negative environmental externality and a more secure energy supply.

Information campaigns are part of the overall Sweden's climate change strategy, thus increasing public awareness of the issue of climate change mitigation. The policy is expected to benefit more vulnerable groups. By addressing climate change impacts, the policy mix also addressed the health dimension (see section 3.1) by potentially decreasing the likelihood of health risks due to substances harmful to the natural environment and positively increasing health through better air, water, waste management and soil quality.

The main issue concerning social impacts on third countries that would be relevant for overarching EU policies is the one of competitiveness concerns arisen by climate-energy policies and of environmental effectiveness (see section 3.2). In principle, climate-energy policies tend to favor non-participating countries (leakage effects). However, it is ultimately difficult to define clearly the winners and losers. For instance lower energy demand from energy efficient countries can damage net energy exporters.

10 Overall assessment

What is your overall view on the success(es) or failure(s) of this policy mix?

How did the policy mix enable decoupling?

How could it have been improved to achieve its original objective(s) and to achieve absolute decoupling?

Climate and energy policy in Sweden has been surely effective in promoting absolute decoupling. On the one hand, energy and carbon taxes (even though the first were initially raised for revenue raising purposes) did reduce and are likely to keep on reducing country CO_2 and GHG emissions. On the other hand, the electricity certificate system has been quite successful in promoting the development of renewable sources. The big question mark is if this effectiveness has been (and will be) efficiently accomplished: many indicators already seem to point out the relative inefficiency of the policy mix. This suggests some possible lines of action to improve efficiency: making the carbon price more uniform within non EU ETS sectors and between non EU-ETS and the EU ETS; limiting the interaction between different instruments and especially between the carbon and the energy tax; limiting the overlap of targets, e.g. renewable vs. energy efficiency; and restricting access to the electricity certificate system to technologies that really require support in addition to that provided by the EU ETS carbon price.

11 Relevance to the EU and transferability

Can the policy mix be applied at the EU level? Is it transferable to other Member States/countries?

What lessons are there that may be of general interest regarding policy mixes and what issues are there as regards transferability of the insights?

Not available.

12 Stakeholder contribution

What insights did stakeholders provide?

No stakeholder consultations were conducted for this case study.

13 References

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