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Analysis of the success in meeting the Swedish national indicative targets for renewable electricity

In accordance with Article 3(3) of Directive 2001/77/EC of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market

Summary

Article 3(3) of Directive 2001/77/EC of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market asks Member States to submit a fourth report including an analysis of success in meeting the national indicative targets by no later than 29 September 2009.

The Annex to the Directive contains reference values for Member States for a percentage contribution of renewable electricity as a proportion of gross electricity consumption in 2010. The percentage for Sweden is 60%. Countries must take account of the reference values when setting their national targets. However, Sweden felt that 60% was too high a figure. The calculations were based on 1997, which was a year of high rainfall with a large amount of electricity produced by hydropower. In a footnote Sweden stated that 51% would be a reasonable level instead of 60%. This was also the reason why Sweden instead opted to set an absolute target with a set amount of renewable electricity production.

For 2003 Sweden set the target of generating 10 TWh of new renewable electricity between the years 2002 and 2010. In 2007 Sweden adopted a more ambitious target with an addition of 17 TWh of new renewable electricity between the years 2002 and 2016.

According to the analysis the *demand* for new renewable electricity statutorily fixed by the electricity certification scheme will be 10.3 TWh in 2010. This calculation is based on the demand for electricity given in the Energy Agency's most recent long-term forecast, 2008[1]. Together with the existing production of renewable electricity Sweden's total production of renewable electricity will be around 82.5 TWh in 2010. This is equivalent to 54.2% of gross national electricity consumption. The calculations are based on a forecast and hence are a source of uncertainty.

Even though the statutorily fixed demand indicates that the national target can be met it is not clear whether the *supply* will be able to cope. We are not sure whether the producers will invest enough in new power to satisfy the demand. The current plans which will probably be implemented are largely sufficient to meet the target. However, the current economic situation may result in elements of the projects being postponed for a few years, which will of course affect this assessment and instead result in an undershoot.

An important precondition for the planned production to be realised is that electricity certification is seen as a trustworthy and stable instrument by investors. Since the scheme was extended to 2030 and the target raised with effect from 1 January 2007 investors now have evidence that the scheme will remain. The scheme has already been well accepted by operators.

The target set is in line with Sweden's climate change commitment. The renewable electricity that is created will help, along with other instruments, to reduce the size of the market which for commercial reasons would probably have been satisfied by means of new natural-gas fired electricity production or imports. In this way the measures will hold back any large increases in CO_2 emissions.

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[1] The 2008 long-term forecast ['Långsiktsprognos 2008, ER 2009:14'] can be downloaded from the Agency's website.

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1. INTRODUCTION

Article 3(3) of Directive 2001/77/EC of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market stipulates that Member States:

"…shall publish, for the first time not later than 27 October 2003 and thereafter every two years, a report which includes an analysis of success in meeting the national indicative targets taking account, in particular, of climatic factors likely to affect the achievement of those targets and which indicates to what extent the measures taken are consistent with the national climate change commitment."

The present report is the fourth Article 3(3) report and must therefore be published prior to 27 October 2007. *[sic]*

1.1. Future reporting

Article 26 of the renewables Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC lays down the amendments which apply to this reporting.

Article 26 Amendments and repeal

1. In Directive 2001/77/EC, Article 2, Article 3(2), and Articles 4 to 8 shall be deleted with effect from 1 April 2010.

2. In Directive 2003/30/EC, Article 2, Article 3(2), (3) and (5), and Articles 5 and 6 shall be deleted with effect from 1 April 2010.

3. Directives 2001/77/EC and 2003/30/EC shall be repealed with effect from 1 January 2012.

Point 1 does not mention this reporting, which occurs in accordance with Article 3(3), and point 3 states that Directive 2001/77/EC ceases to apply from 1 January 2012.

This means that there will also have to be an Article 3(3) report in 2011.

1.2. The national target

The Directive states that Member States must take account of the reference values indicated in the Annex to the Directive when adopting their national target. That Annex gives Sweden's reference value as 60% by 2010. The base year used for the Directive's reference values was 1997, which was a high-rainfall year with a high hydropower production; Sweden's percentage of renewable electricity production that year was 49% compared to 46% in an average year. In a footnote to the Annex Sweden indicated that a reasonable target for Sweden in 2010 would be 52%.

The target adopted by the Swedish Parliament is not the same as the reference value of 60% indicated for Sweden in the Annex to Directive 2001/77/EC. The main reason for this was quite simply that the additional supply for renewable electricity was believed to need to increase by 26 TWh if Sweden was to achieve 60% by 2010. The Government felt that this was unreasonable given the short time left until 2010.

Nevertheless, Sweden set an absolute target (or production target) in TWh. It did so because the target expressed as a percentage of electricity consumption is dependent on weather conditions. Electricity production from hydropower is dependent on precipitation whereas electricity consumption is greatly affected by temperature because Sweden uses a high proportion of electrical heating. The target is also easier to communicate, measure and assess. At the same time, Sweden's Government is trying to stimulate more efficient use of electricity and this will affect the percentage target. Sweden's original national indicative target was to increase the amount of electricity produced from renewable sources by 10 TWh by 2010 compared to 2002. In 2007 Sweden adopted a more ambitious target of an additional 17 TWh of new renewable electricity between 2002 and 2016.

2. COMPARISON WITH AND CONCLUSIONS FROM EARLIER REPORTS

This is the fourth report submitted by Sweden under Article 3(3). Since the first report in 2003 conditions have changed, statistics have been revised and the calculation method has been changed. We give the changes below in bullet form:

- The first national indicative target adopted by the Swedish Parliament meant an increase in renewable electricity by 10 TWh between 2002 and 2010. The Government felt that the target was properly considered in view of the different interests and the introduction and lead times for power investments. That target is now more ambitious: electricity from renewable sources must increase by 17 TWh between 2002 and 2016.

- The main tool for achieving the target is introduction of the electricity certification scheme. It started in May 2003 and has been refined since then. The quota determines the amount of certified electricity which electricity users subject to the quota must purchase out of their total electricity consumption. The quotas can be adjusted at 'control points' so that the target is achieved.

- When the electricity certification scheme started up there was already a certain amount of renewable electricity eligible for certification. In the first report this was estimated at 6.1 TWh when the scheme started in 2003. However, statistics were not complete and new assessments were made. In the 2005 and subsequent reports existing renewable production at the start of the scheme was revised to 6.5 TWh in accordance with the assessment made in Bill 2002/03:40.

- Calculation of the average production accounted for by large-scale hydropower varied in previous reports. It is included in the calculations as a constant and affects the percentages in the different years' reports. It does not affect the amount of new renewable electricity. Since 2005 the Energy Agency has been making use of hydropower's average production in forecasts and in other connections since the method previously used was not transparent and clear. The average hydropower production is now calculated on the basis of mean production from 1985 to the most recent statistics year (2008 in this case). After 1985 there was no significant expansion in large-scale hydropower, which is why it was chosen as the base year. Average production from large-scale hydropower has been adjusted from 63.4 gross TWh in the first report year to 63.8 TWh in the second. In the 2007 report (when the new average production method was used) gross production from large-scale hydropower was 66 TWh (mean production between 1985 and 2006) and in this year's report it is 65.7 TWh.

- The analysis in the 2003 report indicated that Sweden would achieve 50.5% renewable electricity by 2010, equivalent to an actual increase of 10.9 TWh. In the 2005 report the corresponding figures were 51.5% and 11.4 TWh. In the 2007 report Sweden achieves 10.7 TWh but with a percentage of 53.8% by 2010. This year's report indicates that Sweden's percentage will attain 54.2% in 2010 with an increase of 10.3 TWh in renewable electricity.

- When the 10 TWh target was announced in 2002 the Government concluded that such an increase would mean that the percentage of electricity produced from renewable sources would be some 51% in 2010, based on electricity consumption forecasts at the time and the assumption that the hydropower inflow would be equivalent to that in a normal year. This will probably be exceeded.

3. ANALYSIS

3.1. Instruments for achieving Sweden's target

3.1.1 Electricity certification scheme

The electricity certification scheme is the single most important instrument for achieving the target for renewable electricity production.

The scheme was launched in May 2003 and its objective was initially to generate 10 TWh of new renewable electricity in Sweden by 2010 using 2002 as the base year. In its Bill 2005/06:154 the Government proposed amendments to the electricity certification Act (2003:113) aimed at refining and streamlining the scheme by, among other things, extending and increasing its objective. Parliament adopted the Bill on 14 June 2006 so from 1 January 2007 the target is to increase electricity production from renewable energy sources by 17 TWh from the 2002 level by 2016. At the same time the validity of the scheme was extended to the year 2030. The quotas were further adjusted by Finance Bill 2006/07:1 and Parliament's decision on the national budget.

Electricity included in the certification scheme is mostly produced from biofuels and by small-scale hydropower (less than 1.5 MW by the Swedish definition) and wind power. Capacity increases in large-scale hydropower and in new hydropower plant greater than 1.5 MW are also eligible for certification. One certificate is equivalent to 1 MWh of renewable electricity and is issued by the State to producers. It can then be sold on the market, providing producers with additional revenue. In 2008 the average price of a certificate was SEK 287/MWh. This is the average price for all transactions and not the price on the spot market, which is higher.

The scheme generates reliable statistics and provides good analysis opportunities.

3.1.2 Planning targets/planning framework

Setting planning targets or a planning framework for wind power is a way of creating the conditions in the context of community planning for annual production of electricity from wind power at a specific level (expressed as TWh). A planning target therefore provides pointers to how much wind power could be included in a municipality's physical planning. The municipality will identify suitable locations for wind power and record them in the overall municipal plans.

The present planning framework for wind power means, for instance, location plans for wind power equivalent to a planning framework of 30 TWh, 20 TWh of which on land and the other ten at sea. The Energy Agency was commissioned to produce a proposal for a new planning target[2] up to 2020. In 2009 Parliament adopted the planning framework.

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[2] *Nytt planeringsmål för vindkraften år 2020* [New wind-power planning target for 2020], Energy Agency ER 2007:45

3.1.3 Areas of national interest for wind power

Since 2004 there have been land and sea areas indicated as of national interest[3] for wind power. If an area is described as of national interest this means that the Energy Agency regards it as particularly suitable for wind power. Assessment of an area as of national interest is based on a wind rose where wind conditions are analysed to find suitable areas for expanding wind power. County councils and municipalities can then use this as the basis for general planning.

The fact that an area is of national interest for wind power is a guideline when examining land or water use. It therefore first acquires legal significance when a licence application for a project is being examined. The national interest is then assessed vis-à-vis other existing national interests such as nature conservation, reindeer farming, the armed forces, etc.

In 2008 the Energy Agency reviewed the 2004 national interest for wind power based on a new wind rose. The review resulted in more and larger areas. There are now 423 areas in 20 of the country's 21 counties/regions. The areas account for 2.2% of the country's total land mass.

There are maps of the designated areas of national interest on the Energy Agency's website.

3.1.4 Other aspects

Wind pilot aid is an aid measure for the market introduction of large-scale wind power. The measure is aimed at reducing the costs of starting up wind power and promoting new technology. The aid measure, which started in 2003, has been extended to 2012 and increased by SEK 350 million for the period 2008-2012[4].

The environment bonus, a tax subsidy, is decreasing each year until it is phased out at the end of 2009. In 2009 the bonus is SEK 0.12/kWh for electricity from sea-based wind power; it was phased out for land-based wind power at the end of 2008.

Table 1: Environment bonus

	Sea-based (öre per kWh)	Land-based (öre per kWh)
2006	15	6.5
2007	14	4
2008	13	2
2009	12	0

The licensing process was simplified in autumn 2006: plants of up to 25 MW installed output required only notification to the municipality. In 2008 there was a

[3] 'National interest' is a planning tool described in the Environmental Code.

[4] The aid is described in more detail on the Energy Agency's website.

commission of enquiry[5] aimed at simplifying connection to the electricity grid for renewable power plants. One of the commission's proposals was that small power plants could be connected without the hourly metering requirement, resulting in lower costs and relaxation of the concession procedure for the electricity grid, and administrative guidelines on how producers of renewable electricity could come to agreements with the grid companies on connection.

There is investment aid for solar cells targeting both businesses and public bodies, and private persons. The aid is available to installations commenced no earlier than 1 July 2009 and completed no later than 31 December 2011.

Sweden also has a long tradition of long-term research in the energy sector, one example being the State energy research programme which is under the auspices of the Energy Agency. This programme is based on six subject areas: energy system studies, energy use by buildings, the transport sector, energy-intensive industry, fuel-based energy systems and the power system.

The power system sector includes hydropower, wind power, solar cells, wave power, and power transmission and energy storage in the power system. Action aimed at training and skills development is important for future renewal of existing hydropower. Wind power research is aimed at creating the conditions for increasing the proportion of electricity produced by wind power and reducing its cost. The Energy Agency is also conducting trials on sea- and hill-based wind power. The focus in the solar cell sector is on developing cheaper and more efficient cells. Research on power transmission and energy storage in the power system is concentrated on creating a safe and effective system adapted to new technologies and production methods which are increasingly expected to be introduced.

3.2. Correction of average production from hydropower

Hydropower production in Sweden varies within wide limits depending on rainfall. The lowest production since the beginning of the 1980s was in 1996, 52 TWh; the highest production hitherto was in 2001, 79 TWh. Depending on what production is used in the analysis of whether Sweden achieves its target, this has an effect on the proportion as a percentage; it does not affect the absolute national target.

Because of the great variation in hydropower it is necessary to define an average production. Otherwise, assessment of Sweden's national target will depend entirely on rainfall in 2010.

In earlier analyses Sweden had calculated the normal-year production as a statistical mean over a longish period, from 1950 onward. Production of that mean was complicated by the fact that hydropower expanded during the period. Older statistics were therefore corrected for the lower degree of expansion that was the case at that time. In addition, they were not equally reliable or directly comparable with current statistics. Also, the Energy Agency does not have access to all the data that were the basis for that method so during recent years it has avoided using it.

In the present analysis and its most recent forecasts the Energy Agency decided that average production of Swedish hydropower should be calculated as a mean of the

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5 SOU 2008:13 Bättre kontakt via nätet-om anslutning av förnybar elproduktion [*Better contact via the grid – connecting renewable electricity production*]

production from 1985 to the most recent year for which statistics are available, in this case 2008; the figures are therefore 67.2 net TWh and 67.9 gross TWh. 1985 was chosen because since that year there has been no major expansion of large-scale hydropower in Sweden.

Hydropower in its turn is divided into *large-scale* (more than 1.5 MW) and *small-scale* (1.5 MW or less). The latter is eligible for certification under the scheme. The statistics are now available from the electricity certification scheme. Small-scale production has varied between 1 799 gross GWh in 2005 and 2 607 gross GWh in 2008. Normal production for small-scale hydropower has been set at 2.2 gross TWh.

This means that large-scale production is **65.7 gross TWh** in an average year. This figure is included as a ***constant*** in Sweden's analysis on achieving the ***percentage target***.

If large-scale hydropower capacity increases as a result of higher efficiency in existing or new plant, this will be eligible for certification and will therefore appear in the scheme's statistics. The figure of 65.7 TWh can therefore be constant in the analysis.

3.3. Demand for renewable electricity

The demand for renewable electricity[6] (excluding large-scale hydropower) is controlled by the quota in the certification scheme. This determines the proportion of certified electricity that quota-subject electricity consumers must purchase in their total electricity consumption. The quota increases each year; quotas are currently set for each year up to 2030. Current quotas can be seen in Table 3 below. The tables also show the increase in renewable electricity that the scheme has to date produced in absolute figures and the anticipated increase using assessments based on electricity consumption in the most recent long-term forecast, *Kontrollstation 2008*.

Table 2: Definitive quota obligation under the electricity certification Act and calculated amount of renewable electricity in TWh based on the Energy Agency's most recent long-term forecast, 2008

Year	Quota	New renewable electricity(accumulated) in TWh*
2003	0.074	1.96
2004	0.081	4.00
2005	0.104	4.16
2006	0.126	5.10
2007	0.151	6.18
2008	0.163	7.70
2009	0.17	*9.03*
2010	**0.179**	*10.30*

[6] Under the scheme electricity produced from peat is also eligible. However, peat is not renewable in the terms of Directive 2001/77/EC so the quantity of peat in the scheme has been excluded from the figures presented in the analysis.

Source: Bill 2005/06:154; Finance Bill 2006/07:1 and calculations from the forecast on long-term electricity consumption taken from the 2008 long-term forecast.
* N.B.: Forecasts in italic, the remaining figures are actual.

The electricity certification scheme runs until 2030 and the quotas valid for future years can be seen in Table 3.

Table 3: Definitive quota obligation under the electricity certification Act for 2017-2030

Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Quota	0.111	0.111	0.112	0.112	0.113	0.106	0.094
Year	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Quota	0.090	0.083	0.075	0.067	0.059	0.050	0.042

Source: Bill 2005/06:154; Finance Bill 2006/07:1.

With the aid of the forecast in the 2008 long-term forecast it is possible to assess how the demand for renewable electricity will evolve with the certification scheme. In 2010 electricity consumption is forecast at 148 net TWh of which 96.6 TWh is subject to quota, so the demand for renewable electricity can be calculated as 96.6 x 0.179 = 17.3 TWh in 2010. Excluding peat this becomes 16.8 TWh. Because there were 6.5 TWh of renewable production when the certification scheme started demand is therefore equivalent to an increase of 10.3 TWh according to this analysis. The target was an increase of 10 TWh by 2010 but because the quotas are fixed and electricity consumption and the certification scheme have evolved the analysis shows that demand is somewhat higher than planned.

Table 4 Demand for renewable electricity to 2016 and proportion of renewable electricity based on that demand

	Produced renewable electricity	**Proportion of renewable electricity**	**Electricity consumption, gross**
Year	**TWh**	**%**	**TWh**
1997	72.03	49.1	146.7
2002	72.17	47.5	152.1
2003	74.13	50.1	148.0
2004	76.18	50.7	150.3
2005	76.34	50.5	151.1
2006	77.27	52.1	148.4
2007	78.35	52.2	150.0
2008	79.87	54.0	148.0
2009	*81.20*	*54.1*	*150.1*
2010	***82.47***	***54.2***	***152.3***

Source: Energy Agency calculations based on quotas and forecast in 2008 long-term forecast.
* N.B.: Forecasts in italic, the remaining figures are actual.

3.4. Supply of renewable electricity

This is regulated by whether the market manages to meet demand for the additional renewable electricity production created by the certification scheme and by gross

production in large-scale hydropower, which is assumed in this report to be a constant 65.7 TWh.

3.4.1 Renewable electricity today

In 2008 certifiable electricity production was 15.0 TWh. Peat is not a renewable fuel but is included in the certification scheme and is eligible for aid as a highly efficient CHP fuel. Since renewable electricity production is indicated the quantity of peat is therefore excluded. Electricity production from renewable energy sources within the certification scheme amounted to 14.2 TWh in 2008; 6.5 TWh of this already existed in 2002[7]. In comparison with 2002 this is an increase of 7.7 TWh.

Electricity production from renewable energy sources can be increased by setting up new plant or by increasing production in existing plant. A total of 640 new plants were put into operation between the start of the scheme on 1 May 2003 and 31 December 2008. 515 of these were wind-power plants, 41 were biofuel, 80 hydropower and 4 solar.

3.4.2 Planned renewable electricity production

To cope with the increasing demand new plants are being built or planned throughout the country. According to the plans the Energy Agency is aware of, it estimates that nearly 2.3 TWh of new production will be built during the period 2009-2010. The information has been gathered from the companies whose plans are known to the Agency. The list makes no claim to be complete and such plans are constantly changing. In the following text and in Table 5 there is a list of planned renewable electricity in Sweden.

Table 5 Existing and planned renewable electricity in Sweden 2008-2010, GWh

	Existing power	***Planned addition***			**Total**
	2008	***2009***	***2010***	***Total***	**2010**
Biofuel	9 599	*217*	*870*	*1 087*	10 686
Wind	1 996	*470*	*573*	*1 043*	3 039
Water	2 607	*88*	*54*	*141*	2 749
Solar	0.13	*0.10*	-	*0.10*	0.23
Total	**14 203**	*775*	*1 497*	*2 271*	16 474

It is estimated that production could be 16.5 TWh by 2010. Disregarding the renewable power that existed in 2002, 6.5 TWh, there may therefore be an additional 9.97 TWh in 2010 if the assumed expansion schemes are implemented. Sweden's target of 10 TWh increased production can therefore be met.

Existing known plans are therefore nearly enough to meet the demand in the electricity certification scheme and to meet Sweden's target. There are also other projects well-advanced in their planning which will meet the demand for renewable electricity if they are realised.

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[7] In the 2003 report production was quoted as 6.1 TWh in 2002. That figure was revised to 6.5 TWh in Bill 2002/03:40 *Elcertifikat för att främja förnybara energikällor* [Electricity certification to promote renewable energy sources]

An important precondition for the planned production to be realised is that electricity certification is seen as a trustworthy and stable instrument by investors. Since the scheme was extended to 2030 and the target raised with effect from 1 January 2007 investors now have evidence that the scheme will remain. The scheme has already been well accepted by operators.

Wind power

There are many wind-power projects being planned for the next few years; these are at various stages from planning to commencement of construction. The licensing process can often be a time-consuming one for projects. It is therefore difficult to predict exactly when wind-power plants will come on stream or whether projects will actually be carried through. Another reason why projects are postponed to a future date or commencement of production is delayed is the current global economic climate which can make project financing a problem.

The Energy Agency's list of projects attached to this report is based on those already under construction and those which already have licences and which the Agency believes will be built. The Agency has also taken account of the time of the year when the project comes on stream, actual compared to potential production and so on, which means the estimate is a conservative one. In all, these projects will add about 1 TWh in the next two years. Adding up the other wind power projects in the same period gives an addition of another few hundred GWh if all the projects are brought to fruition. The list does not claim to be complete since a few plants and projects of less than 10 MW have not been included.

Biofuel

There are also a number of planned and ongoing projects involving biofuel-fired CHP plants. In the Agency's list of biofuel-fired CHP plants which are to be built or are already being built electricity production is raised by just on 1 TWh during the next two years. Here, too, there are more CHP plants which are planned but not due to come on stream until after 2010.

Hydropower

There is no current expansion of new large-scale hydropower in Sweden. The four unaffected national rivers with relevant water areas and other river stretches worthy of protection are protected by Chapter 4 Section 6 of the Environmental Code (SFS 1998:808) and Natura 2000.

However, there is some potential for higher efficiency and increased production in existing large-scale hydropower. This increase is eligible for certification and will therefore appear in the statistics included in the certification scheme.

Some small-scale hydropower plants in Sweden are being renovated. In the Agency's list of known projects this gives an increased production of just on 0.1 TWh by 2010.

Solar power

In Sweden there are currently nine solar power plants. Four of these have recently started up and will add some 0.1 GWh from 2009.

4. NATIONAL CLIMATE CHANGE COMMITMENTS

In the analysis Member States are also required to indicate to what extent the measures are compatible with national climate change commitments.

In Sweden only a relatively small percentage of carbon dioxide emissions originates in electricity production. In 2004 emissions from electricity production were 2.9 million tonnes, equivalent to 5.6% of the energy sector's total carbon dioxide emissions.

However, changes in the prevailing electricity production mix may occur and electricity consumption is expected to increase more than marginally. The current assessment is that natural-gas based electricity production is the commercially most interesting alternative for investment in new power production.

The electricity certification scheme forces a large volume of electricity onto the market which is not fossil based and which would probably not have been built without aid schemes. This renewable electricity, along with other regulatory instruments, reduces the market share which would probably have been met with natural gas or imports for commercial reasons. In this way the scheme holds back any increases in carbon dioxide emissions.

As an EU Member State Sweden, too, participates in the EU's carbon trading scheme. Electricity production is included in the traded sector.