Preliminary qualitative assessment of proposed measures to foster renewable and low carbon sources in the Dutch electricity mix

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Abstract
This report presents a preliminary qualitative assessment of a selection of proposed measures on support to renewables and reduction of carbon emissions in the Dutch electricity sector. The following proposed measures have been qualitatively assessed in this report:
1. Replace the SDE by the German-type feed-in tariff system.
2. Replace the SDE by a supply-side renewable portfolio standard.
3. Replace the SDE by a demand-side renewable portfolio standard.
4. Introduce a demand-side RPS in combination with the SDE.
5. Impose a generic CO_2 emissions standard on power plants.
6. Impose a biomass co-firing standard on coal-fired power plants.
7. Impose a CCS obligation on coal-fired power plants.

The main conclusion is that, on balance, all these measures but one score poorly on a number of performance criteria. The measure identified as one with superior overall performance is the introduction of a demand-side renewable portfolio standard, also known as quota obligation or renewables obligation, *in combination with the SDE*. The SDE is the prevailing Dutch support system for renewable electricity and gas. The tradable renewable energy certificate (TREC) price would have to be included in the prevailing ex post SDE premium adjustment method.

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Summary

This report presents a preliminary qualitative assessment of a selection of proposed measures on support to renewables and reduction of carbon emissions in the Dutch electricity sector. The measures considered are:

Baseline

- *The current SDE support system.* The SDE is the main Dutch support mechanism to stimulate the share of electricity and gas from qualifying renewable sources in the Dutch electricity mix. The SDE feed-in premium (FIP) system for generators using qualifying renewable energy sources. It is included in the baseline against which the proposed new measures will be assessed.

Proposed measures to help increase the share of renewable electricity in the Netherlands

- *Replace the SDE by the German-type feed-in tariff system.* The German feed-in tariff (FIT) support system has been widely credited for the fast expansion of energy from renewable sources in the German energy supply, with special reference to electricity.
- *Replace the SDE by a supply-side renewable portfolio standard.* A supply-side renewable portfolio standard (RPS) is imposed on generators and importers of electricity: each generator/importer of electricity is required to make sure that the total quantity of electricity that he generates in or imports into the Netherlands in a certain year contains a certain minimum percentage of electricity from qualifying renewable sources.
- *Replace the SDE by a demand-side renewable portfolio standard.* A demand-side RPS is imposed on Dutch electricity suppliers (retailers) and certain Dutch medium-scale/large electricity users. Each of these actors is required to make sure that the total quantity of electricity that he delivers to end-users or uses in a certain year contains a certain minimum share of electricity from qualifying renewable sources.
- *Introduce a demand-side RPS in combination with the SDE.* This measure also encompasses the introduction of a demand-side RPS, similar to the previous measure. Yet unlike the previous measure, the SDE will remain in place.

Proposed measures to for the imposition of additional requirements on non-renewable Dutch electricity generators

- *Impose a generic CO_2 emissions standard on power plants.* This measure requires that each power plant should meet a maximum CO_2 emissions norm, e.g. a standard of 350 grams of CO_2 per kWh generated.
- *Impose a biomass co-firing standard on coal-fired power plants.* This measure requires for each coal-fired power plant that a certain minimum share, e.g. 40%, of the electricity will be produced from (solid, liquid or gaseous) biofuels.
- *Impose a CCS obligation on coal-fired power plants.* This measure requires that each coal-fired power plant applies carbon capture and storage (CCS).

These measures are rated on their performance with regard to ten performance criteria, each on a 1 (very low) to 5 (very high) scale. The choice of criteria is explained in the main text. On the outset it is emphasised that this choice is inherently subjective, as are the ratings of each measure per criterion and their simple method of aggregation to arrive at an overall rating. The ratings are based on qualitative analysis.

Appendix A explains that the choice of the unit of account for the share of renewables can impact on assessing the effectiveness of a measure on raising this share. As the possible introduc-

tion of an RPS is a proposal receiving a lot of attention to date, Appendix B seeks to describe how four RPS systems currently applied in the EU have fared so far. The key message is that an RPS can function well, provided the design details are well defined. In order to do so, the design has to duly allow for specificities of general market framework and, last but not least, the diversity of renewable resources in the RPS area. Technology- and resource-specific features may render supplementary support measures indispensible.

The results of our qualitative assessment are shown in Table S.1 below.

Table S.1 *Qualitative assessment of regulatory and support measures for renewable energy target compliance on distinct criterion aspects*

Support measure	Involved (Dutch) actors	Envir. effective ness	Cost effective ness	Impact Gov. Budget	Afforda-bility	Compatible with SDE	System stability	Fair com-petition	Support innovative technology	Legal robustness	Scope for European harmoni-sation	Σ/n 1)
Baseline												
Current SDE	RES-E generators	4	3	3	2	5	3	3	4	3	4	3.4
Proposed measures												
German FIT	RES-E generators	5	2	3	1	1	2	1	4	2	1	2.2
Supply-Side RPS	Generators + importers	4	1	3	1	1	1	2	1	2	1	1.7
Demand-Side RPS	Suppliers + certain end-users	4	1	3	1	1	1	2	1	2	2	1.8
Demand-Side RPS + SDE	Ditto + RES-E generators	4	4	3	3	5	4	4	5	5	5	4.2
CO2 standard	Power plants	2	1	3	1	5	2	1	2	2	2	2.1
Biomass co-firing standard	Coal-fired power plants	2	1	3	1	5	2	1	2	2	2	2.1
CCS obligation	Coal-fired power plants	2	1	3	1	5	2	1	1	2	2	2.0

1) Overall performance: unweigted average of criterion ratings
Rating legend:
5 : very positive (favourable) impact on criterion aspect / positive impact compared to baseline development by a large extent
4 : fairly positive (favourable) impact on criterion aspect / positive impact compared to baseline by a moderate extent
3 : neutral impact on criterion aspect / neutral impact compared to baseline development
2 : fairly negative impact on criterion aspect / negative impact compared to baseline development by a moderate extent
1 : very negative impact on criterion aspect / negative impact compared to baseline development by a large extent

Source: expert judgment by the author.

Our preliminary assessment yielded a high overall rating for the current SDE on its performance on ten criteria. Its weakest point is affordability. In performing mediocre on the latter criterion, the SDE is not at all unique: meeting the quite ambitious renewable energy targets set costs a lot of extra money!

Based on our analysis, introducing within the coming few years of a demand-side RPS *in combination with the current SDE* deserves serious public consideration. This is the only measure among the considered ones scoring better overall than the SDE, including somewhat on affordability. The other proposed measures considered score (much) worse.

Should a demand-side RPS / SDE be adopted indeed, the development of a good RPS system design from the very start of the scheme is of paramount importance. Many details have to be spelled out, such as choice of qualifying sources, the extent of participation of existing qualifying plants, long-term projections of qualifying gross and net new capacity, long-term projections of electricity from qualifying sources in relation to evolving electricity demand, target setting over a long period, compliance flexibility and enforcement arrangements, and the integration of the TREC price in the ex post SDE subsidy adjustment mechanism, etc. Moreover, the due political and legislative trajectory has to be completed. A prudent fast-track introduction is therefore likely to take no less than three years.

The advantages of a Dutch demand-side RPS / SDE support scheme in achieving the quite ambitious and likewise expensive Dutch renewables targets set at lowest societal cost will increase quite substantially through international co-operation. Sweden would be the most attractive partner in this respect with high mutual benefits to be gained. Hence, in designing a demand-side RPS / SDE scheme early contacts with the appropriate Swedish authorities are recommended to render the scheme - from the outset - compatible with the Swedish support scheme to a major extent.

Also the possibilities for collaboration with the Belgium Regions, in particular Flanders, can not be fully discounted. In spite of major practical problems, also here significant mutual benefits can be gained. Furthermore, the intended change of the Italian RPS from a supply-side to a demand-side one might also be an interesting development in this regard.

The environmental effectiveness and cost effectiveness of a range of proposed measures floated to increase the share of renewables and to reduce GHG emissions in the Dutch power sector is very poor. In this regard, we mention in particular proposals to impose additional standards, aimed directly or indirectly at coal-fired power plants. We have assessed in this regard the imposition of respectively CO_2 standards, biomass co-firing standards, and/or a CCS obligation. These measures seriously undermine the functioning of the EU ETS, the prime instrument to impose carbon emissions reductions *at lowest societal cost* by economic actors participating in this scheme.

Dutch coal-firing generators are participating in the EU ETS. Imposing all sorts of additional carbon-reduction measures on Dutch coal-fired power plants is of no avail to achieving any reduction of carbon emissions EU-wide at all. On the other hand, these measures substantially reduce the flexibility of the affected actors to meet their ETS obligations in the most cost-effective way. The economic damages of the proposed measures concerned to be sustained by Dutch coal-fired power plants will propagate throughout the Dutch economy by means of higher wholesale and end-user electricity prices.

1. Introduction

1.1 Report background

To date, a number of proposals are being considered by the Dutch Parliament and Government to help achieve renewables or carbon emissions reduction goals in the Dutch electricity supply sector. Some proposals demand an adjustment or outright change of the main Dutch support mechanism for the stimulation of electricity from renewable energy sources in the Dutch economy. Other proposals call for the imposition of additional requirements which all or certain categories of Dutch electricity generators would need to meet.

1.2 Report scope

This report seeks to offer some qualitatively substantiated reflections on the public cause regarding a selection of proposals that are currently under consideration. For that purpose, it will assess the following proposed new measures:

Baseline

- *The current SDE support system.* The SDE is the main Dutch support mechanism to stimulate the share of electricity and gas from qualifying renewable sources in the Dutch electricity mix. The SDE feed-in premium (FIP) system for generators using qualifying renewable energy sources. This will set the baseline against which the proposed new measures will be assessed.

Proposed measures to help increase the share of renewable electricity in the Netherlands

- *Replace the SDE by the German-type feed-in tariff system.* The German feed-in tariff (FIT) support system has been widely credited for the fast expansion of energy from renewable sources in the German energy supply, with special reference to electricity.
- *Replace the SDE by a supply-side renewable portfolio standard.* A supply-side renewable portfolio standard (RPS) is imposed on generators and importers of electricity: each generator/importer of electricity is required to make sure that the total quantity of electricity that he generates in or imports into the Netherlands in a certain year contains a certain minimum percentage of electricity from qualifying renewable sources.
- *Replace the SDE by a demand-side renewable portfolio standard.* A demand-side RPS is imposed on Dutch electricity suppliers (retailers) and certain Dutch medium-scale/large electricity users. Each of these actors is required to make sure that the total quantity of electricity that he delivers to end-users or uses in a certain year contains a certain minimum share of electricity from qualifying renewable sources.
- *Introduce a demand-side RPS in combination with the SDE.* This measure also encompasses the introduction of a demand-side RPS, similar to the previous measure. Yet unlike the previous measure, the SDE will remain in place.

Proposed measures to for the imposition of additional requirements on non-renewable Dutch electricity generators

- *Impose a generic CO_2 emissions standard on power plants*. This measure requires that each power plant should meet a maximum CO_2 emissions norm, e.g. a standard of 350 grams of CO_2 per kWh generated.

- *Impose a biomass co-firing standard on coal-fired power plants*. This measure requires for each coal-fired power plant that a certain minimum share, e.g. 40%, of the electricity will be produced from (solid, liquid or gaseous) biofuels.
- *Impose a CCS obligation on coal-fired power plants*. This measure requires that each coal-fired power plant applies carbon storage and sequestration (CCS).

1.3 Report outline

Chapter two presents (i) the general policy framework in which proposed new measures for the electricity supply sector have to fit, (ii) historical trends regarding deployment of renewables in the Netherlands and introduces the criteria for the qualitative assessment of selected proposed new measures. The assessment itself is undertaken in Chapter 3. Conclusions and recommendations are presented in Chapter 4.

Two Appendices complement this report. Appendix A explains three different units of account for the share of renewables and some implications on for target accounting. Appendix B describes four RPS systems currently applied in the EU.

2. Policy targets, renewables trends and applied assessment criteria

2.1 Introduction

This Chapter sets the stage for the assessment of a selection of proposed policy measures for the Dutch electricity sector to help achieve environmental targets. Section 2.2 introduces the most recent key policy package of the EU and the Netherlands respectively on energy and environment. Trends regarding renewable energy supply in the Netherlands are presented in Section 2.3. Finally, Section 2.4 explains the criteria to be applied for the assessment.

2.2 EU 'Energy and Climate' and 'Clean and Efficient' policy packages

The 2008 EU Energy and Climate package implies the following energy targets for the Netherlands:

- A mandatory reduction target for greenhouse gases (GHG) of **21%** compared to GHG emissions in year 2005 for Dutch and non-Dutch installations alike, falling under the EU emissions trading system ETS (including large fossil-based power plants). This is possibly to be tightened contingent on the assessment by the European Council and Parliament of evolving GHG policies by major EU partners in the aftermath of the Copenhagen climate change Conference. The EU is responsible for the EU ETS sector. In fact, the European Commission rather than the Dutch government is responsible for compliance enforcement by obligated actors under the EU ETS, including the operators of Dutch installations within the EU ETS.
- A mandatory GHG emissions reduction target for the non-ETS sector for the Netherlands in 2020 with regard to corresponding emissions in year 2005 of **16%**, possibly to be tightened further by a percentage level to be established later contingent on the assessment by European Council and Parliament evolving GHG policies by major EU partners; the individual Member States are responsible for controlling their GHG emissions in the non-ETS sector
- *A mandatory target of **14%** renewables in final energy consumption*
- A mandatory target of **10%** automotive transport fuels from renewable sources including renewable electricity
- An indicative target of **20%** energy efficiency improvement with respect to an officially unspecified baseline (presumably the baseline of the 2005 PRIMES scenario).

The most important targets of the EU Energy and climate package are the two first ones on GHG emissions reduction. They are both susceptible to upward revision, should the European Council consider the results of COP-15 in Copenhagen and its aftermath adequate to do so. In that case the overall Community GHG reduction target will be revised from **20%** to **30%** with respect to EU-wide GHG emissions in year 1990. The fact that Member State governments are only responsible for compliance with 'their' target for the non-ETS sector introduces perverse incentives to stimulate technology transitions that shift GHG emissions from non-ETS activities to the ETS sector.[1] For example shifting gas-based space conditioning services to electricity-based space conditioning services not only improves long-term supply security but also reduces the burden of compliance with the non-ETS emissions reduction target for, say, the Netherlands (Werring, 2008). This might be an important consideration regarding the possible stimulation of technologies like ambient and geothermal heat pumps and electric transportation, notable electric vehicles.

[1] Perverse effects include adverse impacts on non-power installations under the ETS and lower pressure on other non-ETS activities towards decarbonisation. These effects may well be sub-optimal from a welfare economics perspective.

The indicative targets specified by the Dutch Balkenende-4 government coalition agreement and elaborated in the 2007 Clean and Efficient policy package are:

- GHG emissions reductions ($tCO_{2\ eq.}$) in 2020 compared to GHG emissions in 1990 by **30%**
- *A share of renewables in gross energy consumption in 2020 of **20%**.*

2.3 Targets mandated by Renewables Directive 2009/28/CE

On 17 December 2008 the European Parliament endorsed the new Directive on the promotion of the use of energy from renewable sources (European Union, 2009). As explained in the previous chapter this Directive sets a mandatory target for each Member State, i.e. **14%** for the Netherlands. EU-wide target compliance would bring the renewable energy share in the EU's final energy consumption at 20% by 2020. As part of the overall target, a binding minimum target is set for each Member State including the Netherlands regarding the share in total in-lands automotive transport fuel consumption originating from renewable source such as 'sustainable' biofuels and renewable electricity. This mandatory standard is specified at **10%.**

The potential cost for reaching *in-lands* the national renewables targets do vary widely across MS. The marginal cost to achieve *in-lands* the last marginal target accounting units of the **14%** national 2020 renewables target, as mandated for the Netherlands by the Renewables Directive, are appreciably higher compared to most MS. Therefore, the EU at large - and in particular the Netherlands - was to gain an amount of socio-economic welfare to the tune of several tens of billion euro per year by EU-wide trade in renewable energy. The Commission recognised this and promoted an integrated [2] certification concept of renewable energy (so-called Guarantees of Origin) with EU-wide trading possibilities, albeit with certain MS opt-out options. Yet just a few days before the Commission was due to launch its then Draft Renewables Directive in January 2008, interventions at the highest level by two large MS fearing legal challenges to their national support systems forced the Commission to completely relinquish the integrated renewable energy certification concept. The Commission and other participants in the trilogue negotiation process prior to the adoption of the Renewables Directive sought to mitigate the loss of EU-wide socio-economic welfare in the absence of an internal market for renewable energy. This led to the introduction of four flexible mechanisms in the Renewables Directive without the MS having to involuntarily relinquish control over their respective support systems and renewable energy potentials.[3]

Every two years the Member States are to report on the share of renewables they have achieved and the measures they have implemented. The Renewables Directive specifies the following interim targets: 20% of the final 2020 target in 2011/2012 (i.e. **2.8%** for the Netherlands); 30% in 2013/14 (**NL: 4.2%**); 45% in 2015/16 (**NL: 6.3%**); 65% in 2017/18 (**NL: 9.1%**). Unlike the 2020 target, these interim targets are indicative. Yet should the Commission deem any time as from the date of adoption of the Renewables Directive, that a Member State undertakes insufficient efforts to comply with the Renewables Directive, the Commission is entitled to start infringement procedures against the Member State concerned.

The Netherlands do not have a specific target for renewable electricity. Analysis of PBL/ECN (Verkenning Schoon en Zuinig ECN-E-09-022, Ton van Dril et alia) shows that currently planned policy plans can lead to 35% renewable electricity and to about 16% renewable energy (both in terms of primary energy applying the substitution principle and final energy consumption). The government (see EZ, 2009) has indicated the required budget for 35% renewable

[2] The first conceptualisation of an integrated certification concept for renewable electricity was made in 2003 (Jansen, 2003a). A report launched by CEPS contributed useful insights for the design of the integrative renewable energy certification approach initially advanced by the Commission (Jansen et al., 2005).

[3] Notably a proposal advanced jointly by the German, Polish and UK governments had a strong impact to that effect.

electricity. As such, the electricity target of 35% is not a formal target but it is often used in political discussions. A 35% RES-E share in Dutch electricity supply seems to contribute sufficiently to the European target of 14%. Even if this 35% share were to be achieved indeed, the national target of 20% renewables would still seem to be out of reach.

2.4 Trends in Dutch renewable energy performance

The CBS has compiled a table showing the renewable energy performance of the Netherlands in 2008 applying three calculation methods explained in the previous Section. We reproduce this table below (Table 2.1). The table indicates that in year 2008 according to the accounting method of the Renewables Directive the Netherlands stands at 3.7% (including heat pumps and biofuels). This compares e.g. to the indicative average target for the Netherlands in years 2011/12 amounting to 2.8% and a mandatory target of 14% in year 2020 (see Section 2.3 above). For the time being, the Netherlands is above its indicated target trajectory but the road to 14% is poised to be quite tough. The largest contributions as shown in the fourth column of Table 2.1 are made by the following technologies:

- Wind energy (14.1 PJ, i.e. 10^{15} joules)
- Biofuels for road transport (14.0 PJ)
- Heat pumps (9.9 PJ)
- Household wood stoves (9.3 PJ)
- Biomass co-firing in large-scale power plants (9.0 PJ)
- Municipal waste, renewable fraction (9.0 PJ)
- Other biomass combustion (6.5 PJ)

Table 2.1 *Renewable energy performance of the Netherlands according to three distinct calculation methods*

	Substitution	Primary energy	Gross final energy consumption according to the EU directive on renewable energy	
			With heat pumps and biofuels	Without heat pumps and biofuels
	TJ			
Hydro power	840	367	360	360
Wind energy	35,061	15,322	14,053	14,053
Solar electricity	330	138	138	138
Solar heat	861	879	879	879
Heat pumps	4,622		9,884	
Heat/cold storage	820		113	113
Municipal waste, renewable fraction	12,716	29,266	9,004	9,004
Biomass co-firing in large scale power plants	19,692	19,692	9,143	9,143
Wood stoves for heating in industry	2,508	2,678	2,678	2,678
Household wood stoves	5,464	9,316	9,316	9,316
Other biomass combustion	9,111	12,825	6,486	6,486
Landfill gas	1,307	1,778	828	828
Biogas from sewage purification plants	2,262	2,046	1,815	1,815
Biogas on farms	2,845	3,691	1,435	1,435
Other biogas	1,679	1,782	1,336	1,336
Biofuels for road transport	14,032	14,032	14,032	
Total renewable energy	114,151	113,811	81,501	57,584
Total use of energy (PJ)	3,319	3,330	2,227	2,227
Share of renewable energy (%)	3.4	3.4	3.7	2.6

Source: CBS, 2009: Table 2.4.5.

It is interesting to observe historical trends as well. These are shown in Table 2.2 below, again compiled by the CBS (CBS, 2009). This table provides an overview of renewable energy developments in the Netherlands, including the penetration of renewable energy technologies in Dutch renewable energy supply (RES) over the period 1990 - 2008. The figures in the table are based on the substitution method (avoided primary energy from fossil sources and avoided CO_2 emissions) as defined by the Protocol Monitoring Renewable Energy (SenterNovem, 2006).[4] We do not dispose of trend figures covering such a large period based on the final energy use method mandated by the Renewables Directive. Yet the year on year trend figures - as against

[4] See Appendix A for a brief review of energy *numéraires* and their diverging impact on target accounting.

the relative share figures within a year - are by and large not much influenced by the choice of renewable energy accounting *numéraire*.

Table 2.2 *Renewable energy performance of the Netherlands according to substitution method as defined by the Protocol Monitoring Renewable Energy*

	1990	1995	2000	2005	2006	2007	2008**	2008**
Avoided use of fossil primary energy (PJ)								*Share within renewable energy (%)*
Combination of source and technology								
Hydro power	0.8	0.8	1.2	0.7	0.9	0.9	0.8	0.7
Wind energy	0.5	2.8	6.9	17.2	22.5	28.2	35.1	30.7
Solar								
Solar electricity	0.0	0.0	0.1	0.3	0.3	0.3	0.3	0.3
Solar heat	0.1	0.2	0.4	0.8	0.8	0.8	0.9	0.8
Ambient energy								
Heat pumps	.	0.3	0.6	1.8	2.6	3.4	4.6	4.0
Heat/cold storage	0.0	0.0	0.2	0.5	0.6	0.7	0.8	0.7
Biomass								
Municipal waste, renewable fraction	6.1	6.1	11.4	11.9	12.4	13.0	12.7	11.1
Biomass co-firing in large scale power plants	–	0.0	1.8	30.5	29.4	15.7	19.7	17.3
Wood stoves for heating in industry	1.3	1.6	1.8	1.9	2.1	2.4	2.5	2.2
Household wood stoves	6.2	5.3	5.7	5.5	5.5	5.5	5.5	4.8
Other biomass combustion	0.4	0.6	2.3	4.4	5.3	5.6	9.1	8.0
Landfill gas	0.3	2.1	1.9	1.6	1.5	1.4	1.3	1.1
Biogas from sewage purification plants	1.9	2.2	2.3	2.1	2.1	2.1	2.3	2.0
Biogas on farms [3)]				0.1	0.5	1.4	2.8	2.5
Other biogas	0.5	0.8	1.0	1.2	1.4	1.4	1.7	1.5
Biofuels for road transport	–	–	–	0.1	2.0	13.0	14.0	12.3
Type of energy								
Electricity from domestic sources	6.3	10.6	22.0	60.3	65.4	59.0	74.6	65.4
Heat and cold	10.4	10.3	13.7	18.5	20.9	22.6	24.3	21.3
Gas	1.4	1.9	1.9	1.6	1.5	1.3	1.2	1.1
Transport fuels	0.0	0.0	0.0	0.1	2.0	13.0	14.0	12.3
Total use of renewable energy	18.1	22.8	37.6	80.5	89.8	95.9	114.2	100.0
Calculation of the share of renewables in energy supply								
Total energy use in the Netherlands (PJ) [2)]	2,702	2,964	3,065	3,311	3,233	3,353	3,330	
Contribution of renewable energy to the national energy balance sheet of Statistics Netherlands (PJ)	31	36	55	94	100	106	125	
Total use of energy in the Netherlands with renewable sources according to the substitution method (PJ)	2,689	2,951	3,048	3,298	3,222	3,343	3,319	
Share of renewables in energy supply (%)	0.7	0.8	1.2	2.4	2.8	2.9	3.4	
Calculation of avoided emissions of CO_2								
Avoided emission of CO_2 due to the use of renewable energy (kton)	1,124	1,454	2,480	5,659	6,138	6,765	7,939	
Total CO_2 emission in the Netherlands (Mton) [1)]	159	171	170	176	172	173	.	
Avoided emission of CO_2 due to renewable energy (% of total CO_2 emissions) [1)]	0.7	0.9	1.5	3.2	3.6	3.9	4.6	

Source: CBS, 2009: Table 2.1.1.

2.5 Assessment criteria

The trade-offs that have to be made in choosing measures and policies in the Dutch electricity sector to foster environmental policies are rather complex as many distinct stakeholders are implied. Stakeholder groups include:

- Dutch citizens (taxpayers; employed and unemployed; some highly environmental concerned, others less so)
- domestic electricity users (some very sensitive to their energy bill, others more concerned about environmental impacts)
- project developers using distinct renewable electricity technologies (with not necessarily always co-inciding interests)
- renewable electricity equipment manufacturers
- generators using non-renewable generation technology (some low-carbon; most of them high-carbon generation technology)
- fuel business companies supplying non-renewable and biofuels-firing generators
- electricity suppliers: some larger incumbent ones, other 'green' niche players
- industrial electricity users: some 'shielded' against foreign competition, some others highly exposed to competition originating from other EU Member States and from the rest of the world
- business counterparts in other EU Member States and outside the EU (sensitive to trade distortions possibly engendered by Dutch policy measures)

- current and future generations of humanity, flora and fauna species facing environmental impacts.

Policy makers have to weigh the often quite divergent real and perceived impacts of measures considered with regard to very different concerns at stake. We have attempted to use criteria that account for the most important concerns among stakeholders. Evidently, the choice of assessment criteria is inherently subjective. Unavoidably some of these criteria are to a certain extent (positively or negatively) associated which each other, yet no pair of criteria does perfectly so. Hence each criterion below accounts incrementally for certain major concerns in addition to all other criteria used.

The following criteria, if and when applicable, will be considered in assessing each of the aforementioned proposals:

a. *Environmental effectiveness*. For support measures to the deployment of renewable electricity the following performance criterion is taken: additional renewable electricity volume (in TWh) or generating capacity (in MW) attributable to a support measure. For additional environmental measures imposed on non-renewable generators a second criterion is considered as well: reduction impact on EU GHG emissions[5] and global GHG emissions.
b. *Cost effectiveness*. The extent to which a support measure leads to lowest cost of supported renewable electricity per MWh. Performance on this criterion provides rough indications for gauging macro-economic impacts, for example impact on Dutch GDP and employment.
c. *Public Finance*. Direct impact of a support measure on the Dutch public finance position. Is the measure budget-neutral, will it be a net drain on the budget or does it bring in net public revenue. In this regard, we do not account for indirect effects as these are broadly accounted for by the previous criterion.
d. *Affordability*. Impact of a measure on the financial position of various electricity-using stakeholders: the energy bill of Dutch end-users; the attractiveness of the general conditions for the Dutch business sector.
e. *Compatibility with SDE*. The Dutch support system for renewable electricity has been subject to rather frequent changes, raising policy uncertainty to which investors perceive to be exposed. A major concern of developers of renewable electricity projects is continuity in the renewable electricity support system. Compatibility of a measure with the current SDE system will help to mitigate policy uncertainty concerns.
f. *System stability*. Stability of a measure: can it be expected that a measure, once implemented, will remain in place for a long period of time relative to the turnover period of investments in electricity generation? This again concerns certainty to investors but especially the investors in non-renewable power generation.
g. *Fair competition*. Impact of a measure on fair competition in the electricity supply industry (windfall profits; entry barriers for new market players; market foreclosure; biases in favour of / detrimental to: integrated or non-integrated, large or small market players, specific renewable generating technologies; scope for specialised players; impact on international competitiveness of ‘exposed’ electricity-intensive industries)
h. *Stimulation of innovative technologies*. Flexibility of a measure to provide technology-specific support for promising pre-commercial innovative technology.
i. *Robustness to legal challenges*. Robustness of a measure to possible litigation by negatively affected stakeholders in a disproportionate way, seeking dismantling of the measure.
j. *European harmonisation*. The Netherlands would benefit a lot from the gains from (renewable electricity) trade without loss in EU-wide environmental effectiveness, as the marginal costs of deploying additional renewable electricity in the Netherlands are higher than in most

[5] Note that the fossil-fuels-firing power generation sector, apart from very small generators, falls completely under the EU-wide emissions trading system (ETS). Hence irrespective of the support system for renewable energy that a Member State applies, the ETS target is *EU-wide*, whilst the Commission - not the Member State governments - ensures adequate enforcement of ETS obligations by ETS participants. Hence, it only makes sense to consider the impact of measures in the Dutch electricity generation sector on total *EU-wide* emissions and not on *Dutch* emissions for sheer target accounting purposes.

other Member States, assuming the same ambition level in financing the additional costs in this respect. Therefore, the criterion considers the scope of a support measure to facilitate harmonisation of the Dutch support measure with the corresponding one of (an)other Member State(s), referred to as 'joint support systems' in Renewables Directive 2009/28/CE, and for application in a transition towards an EU-wide internal market.

3. Assessment of the selected proposed measures

3.1 Introduction

This report is focused on targets regarding the share of renewable electricity in total Dutch electricity consumption rather than the share of renewables in total Dutch energy consumption. We do not consider renewable heating and cooling nor do we consider renewable transport fuels. Hence, we assume that for achieving its renewables target, the Dutch government has a renewables sub-target in place for the electricity sector. Indeed, official government statements have been made pointing at a - quite ambitious - sub-sector target of 35 %[6] in 2020.

In our assessment we assume that the Netherlands has an adequate implementation system in place for the deployment of renewable electricity. The reason is to have a good basis for comparison of alternative support systems and regulations. Whatever support system a country may have, no support system can be highly effective if essential complementary regulations and implementation practices are not adequate. This includes fast permitting procedures for project developers and adequate grid integration by public transmission or distribution grid operators of electricity from generators connected to their system. In practice, this may not always be the case. Generally TenneT and the Dutch distribution system operators do a great job on grid integration, compared to their peers in other Member States. The ownership unbundling of electricity networks, as implemented in the Netherlands, is particularly helpful in this regard. Yet on the permitting, improvement is still needed. It should be stated that the Dutch government is addressing this issue currently markedly better than was the case until recently.

The assessment in this chapter is based on qualitative analysis of the impact of a selection of proposed measures and assessment criteria to be presented in this chapter. It has been attempted to analyse the distinct measures from the perspective of the public cause. The selection of proposed measures and assessment criteria was introduced in Section 2.5. It is emphasised that the qualitative analysis and the consequent assignment of performance ratings are based on subjective judgments by the author.

3.2 The current SDE support system

Mid-2003 a feed-in premium system was introduced in the Netherlands as the main support mechanism of renewable electricity, the so-called MEP system. Subsequently, after a void interim period, the MEP system was replaced by the SDE system as per 1 April 2008. Main reforms with the introduction of the SDE system are: (i) the introduction of an ex post power price indexation adjustment to reduce windfall profits and (ii) the change the Dutch support system from open-ended to closed-ended to contain total expenditure on the support system.

The ‘Stimuleringsregeling Duurzame Energie’ (SDE) is the Dutch government’s main subsidy instrument in support of the application of renewable energy in The Netherlands. Both the production of renewable electricity and green gas are supported under the SDE scheme. It is a so-called feed-in premium (FIP) system. The premiums are technology-specific for renewable energy technologies, qualifying for SDE support in accordance with SDE regulations set by the Dutch government. For each qualifying technology, the premium is set at a level that envisages to fully cover the additional production costs needed to make the renewable energy carrier produced (electricity or gas of a specified quality) competitive in the relevant Dutch market at a

[6] Reference is made to the letter of the Minister of Economic Affairs to the Dutch Lower House of Parliament (EZ, 2009) in which a sub-target of 35% renewable electricity for year 2020 is mentioned.

standard of return to developers of projects deploying the renewable energy technology concerned. Each year, the production costs are determined for the different renewable energy technologies, supported in the SDE scheme.[7] During the subsidy period of 15 years[8] the production costs are fixed; the premium is adjusted annually ex post solely on account of changes in average market prices in the relevant electricity and gas markets. In SDE terminology the above is summarized as follows: from the production costs a *base tariff* is derived. The base tariff takes into account the additional costs for the generator of electricity production and sales, including the cost for imbalance settlement. The payable *subsidy tariff* equals the *base tariff* minus the *correction tariff*. The subsidy tariff is set each concession year at an ex post adjusted level so as to stabilise the average income of the energy producer per unit of energy in successive years.

Yet a ceiling for the subsidy tariff is defined: the *base electricity or gas price*, which equals two thirds of the projected electricity or gas price. If the realised relevant energy prices turn out to have skidded below two thirds of the ex ante projected price level, the subsidy tariff is capped. *Hence, electricity generators benefiting from SDE support run a certain (modest) price risk: at very low electricity prices the SDE subsidy cap might become binding.* Each year the correction tariff for the current year will be estimated in advance; based on this estimate an up front payment of 80% of the subsidy is made. In the November the paid subsidy will be corrected for the actual correction tariff based on realized energy prices. A ceiling to the total subsidy payable over the subsidy period for the different SDE technology categories is set yearly by the Minister. The ceilings can help to contain windfall profits due to too high cost estimates as a basis for setting the subsidy level for a particular category qualifying for SDE subsidy. Moreover, total subsidy disbursements to high-additional-cost categories can be duly contained as well. On the other hand, for all stakeholders including high-additional cost generators and their equipment suppliers it is important that the annual SDE allocations for specific categories display a stable pattern over time.

The performance of the SDE on the distinct criterion aspects is analysed hereafter.

Environmental effectiveness. Since the introduction of feed-in premiums in the Netherlands the share of renewable electricity has risen from 3.3% in 2003 to 7.5% in 2008 (See Table 3.1 below). The total RES-E volume in 2008 amounted to 9.0 TWh as against 3.6 TWh in 2003. The Netherlands is well-placed to achieve the 9% indicative target, specified in Renewable Electricity Directive 2001/77/CE. Especially, wind onshore expanded rapidly. Also biomass co-firing and the bio-degradable fraction of municipal waste also make major contributions to the renewable electricity performance of the Netherlands. It is noted, that the environmental benefits of these options are not entirely positive. We refer to the attendant local pollutant emissions and possible sustainability issues regarding imported biomass feedstock for co-firing. On balance, the Dutch performance on environmental effectiveness is reasonably good allowing for the Netherlands' moderate low/medium-additional-cost renewable energy resource endowments. Although the SDE instrument is introduced rather recently, there is a broad-based agreement among stakeholders that it works effectively. To date, the Netherlands is on track with the first steps to meet the 14% renewables target in 2020 stipulated in Renewables Directive 2009/28/CE. This does not detract from the fact that the next steps will be quite difficult but feasible if policy efforts will be further intensified with likewise increasing support cost.

[7] Note that certain generic renewable energy technologies with a wide cost bandwidth are split further into separate qualifying categories with much less diversity in cost performance. This procedure seeks to further reduce windfall profits of SDE beneficiaries.

[8] For thermal conversion of biomass and the digestion options supported under SDE, both for the production of electricity and green gas, the subsidy period is set at 12 years.

Table 3.1 *Net renewable electricity production in the Netherlands, 1990 - 2008*

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008**
Wind, of which	56	317	829	825	946	1,318	1,867	2,067	2,733	3,438	4,256
onshore	56	317	829	825	946	1,318	1,867	2,067	2,666	3,108	3,660
offshore	–	–	–	–	–	–	–	–	68	330	596
Hydro	85	88	142	117	110	72	95	88	106	107	102
Solar	0	1	8	13	17	31	33	34	35	36	38
Biomass, of which	579	809	1,695	2,037	2,556	2,225	2,968	4,831	4,715	3,569	4,592
renewable fraction of municipal waste	462	530	1,003	962	942	959	931	1,001	1,029	1,116	1,058
co-fired in large scale power plants	–	4	198	563	1,082	757	1,539	3,310	3,103	1,711	2,181
other biomass combustion	33	35	216	221	216	205	217	235	235	254	667
landfill gas	16	138	153	160	176	166	134	127	123	111	104
biogas from sewage purification plants	64	97	108	115	119	111	126	119	128	139	145
biogas on farms 3)								9	55	173	340
other biogas	4	7	16	16	21	27	21	31	42	65	97
Total renewable 1)	720	1,215	2,674	2,992	3,629	3,645	4,963	7,020	7,589	7,149	8,988
Total net electricity consumption 2)	78,582	88,947	104,943	107,144	108,452	109,965	114,625	114,471	116,085	118,463	119,226
Renewable fraction in net electricity consumption (%)	0.9	1.4	2.5	2.8	3.3	3.3	4.3	6.1	6.5	6.0	7.5

Source: Statistics Netherlands.

1) Saving of electricity by heat/cold storage is not included.
2) Including distribution losses, excluding use for electricity production. Calculated as the sum of final use of electricity plus the input for other transformations from the national energy balance sheet of Statistics Netherlands.
3) Included in other biogas to 2004.

Source: CBS, 2009: Table 2.1.1.

Cost effectiveness. A certain trade-off exists between environmental effectiveness and cost effectiveness. With respect to the former MEP system and to the German FIT system, the cost effectiveness of the SDE system compares favourably. Firstly, the closed-end nature and the moderate market support to - to date - high-additional-cost technology such as solar PV contain the average unit cost of SDE-supported renewable electricity. Second, the social cost of renewable electricity generation in the Netherlands is mitigated, compared to Germany, by balancing responsibility to which in the Netherlands all actors connected to the public electricity grid are subjected, whilst the EEG imposes socialisation of these costs.[9] On balance, the SDE system scores reasonably on cost effectiveness.

Impact on Government budget. Currently, the SDE subsidies are paid from the Dutch central government budget. As, at least for the time being, EU legislation condones protectionist Member State policies on renewable electricity generation. As a result, trade in renewable electricity between the Member States is virtually absent. In turn, Member States with limited relatively cheap renewable energy resources such as the Netherlands will have to rely more heavily on the development of - to date - high-additional-cost potentials such as offshore wind to meet their respective 2020 mandatory targets. Anticipated expenditures on SDE market support are poised to rise substantially in the coming years (EZ, 2009). In order to neutralize the impact on the government budget, the Dutch government intends to change the financing method from budgetary financing to financing to surcharges on the monthly end-user bill. In our assessment we assume this change in financing method to be implemented.

Affordability. Quite ambitious renewable energy targets and virtually absence of gains from trade render renewable energy support increasingly less affordable for Member States with limited access to low/medium-additional-cost renewable energy sources, such as the Netherlands. Should this situation persist into the medium-term future, the SDE system scores less bad than pure FIT systems. The latter systems, e.g. the German EEG, offer a range of supplementary biases in favour of qualified renewable generators apart from fixed, preferential commodity prices and quite high deadweight administrative cost (see Section 3.3 hereafter). The SDE also scores less bad on affordability compared to a pure RPS (renewable portfolio standard) as the level of overall windfall profits is appreciably higher in the case of a pure RPS (see Section 3.5 below).

Compatibility with the current SDE system. Perfect.

9 It is acknowledged that the German feed-in law allows for the voluntary curtailment of renewable electricity injections in Art. 4(1) of the EEG (Langniß et al., 2009: 1291).

System stability. The fairly ad hoc nature of the fixing of yearly technology-specific allocations in the SDE budget and the production cost for new vintage generation technologies give rise to uncertainty and to wheeling and dealing in the political arena. In the event that there is too little continuity in annual budget allocations for the distinct SDE technology categories, this may negatively affect investors' confidence. Moreover, the fast rising cost of market support to renewable energy in the Netherlands is poised to meet with rising resistance among the Dutch population. The fast rising cost of support to renewables to achieve set targets is not a SDE-specific problem: in fact the SDE scores fairly well on cost effectiveness as explained under the affordability criterion above.

Fair competition. Regarding the method applied to establish the payable subsidy tariffs, the resulting subsidy distortions can be considered 'proportionate' and in line with the community guidelines on state aid for environmental protection (European Union, 2008a). A certain amount of windfall profits may result from asymmetric information problems and perverse results from political wheeling and dealing in ad hoc annual decisions on technology-specific tariffs and support budgets. Especially, the political wheeling and dealing can create unequal competitive positions for project developers operating with different renewable electricity technologies. Yet this is dwarfed by the windfall profits that would result from e.g. copying less well designed RPS systems in e.g. the UK or Italy.[10] On balance, contingent on a low extent of political interference in the decisions on technology-specific tariffs and budget ceilings the SDE scores reasonable on the fair competition criterion.

Opportunities to support innovative technology. The SDE system permits to stimulate 'learning by doing' for promising high-cost renewables like solar PV. Limited (closed-end) market support with year-on-year continuity would appear helpful. Yet focused RD&D support for such, to date, commercially immature technology is a crucial additional component to accelerate its eventual commercialisation.

Legal challenges. In the short to medium term European legislation on the promotion of renewable energy will have to be adapted to render it more compatible with the transition towards a single European market. The distortions of the current SDE system would seem more 'proportionate' than e.g. the German feed-in system. Firstly, the 'commodity' part is exposed to market competition. Furthermore, to date, the supplementary biases pro qualified renewable generators are less in the Netherlands than in Germany. This applies notably to balancing responsibility. An issue might be that legal changes in national legislations are warranted towards harmonised methods for fixing the technology-specific payable tariffs, with due regard for location specific availability of renewable resources. Market deployment at the European level of an option such as offshore wind could accelerate importantly after support harmonisation with faster capture of economies of scale and learning by doing effects.

Scope for European harmonisation. As discussed under the preceding criterion, the SDE system might evolve as a component in a drive towards EU-wide harmonisation of market support to commercially less mature renewable energy. On longer term, all major subsidy schemes and other concessions to renewable generators will have to be phased out (Jansen et al., 2005). Periodic reviews are necessary to assess as to whether sufficient progress has been achieved on the road towards eventual commercial maturity of currently 'promising' technology.

3.3 Replace the SDE by the German-type feed-in-tariff system

In 1991 the German feed-in tariff (FIT) system was introduced by adoption of the *Erneurbare Energien Gesetz* (EEG: German feed-in law). The EEG requires an immediate commercial transfer of qualified renewable electricity to electricity (retail) suppliers. Network operators and,

[10] See Appendix B for a brief overview of the RPS systems in Flanders, Italy, Sweden and the UK.

ultimately, suppliers are required to accept delivery of power from qualified renewable electricity generators at technology-specific preferential prices. They also have to assume the cost of balancing the injections of qualified renewable electricity into the grid on a *pro rata* basis. Eligible renewable electricity generating plants are granted a set technology-specific fixed preferential price concession for generally a period of 20 years. These concessions are granted on an open-ended basis, also for technologies with currently still high additional costs (relative to power from conventional sources), such as PV. The open-ended character of the EEG stands in stark contrast with the Dutch SDE support mechanism. The price fixing for wind power plants during the concession period is more complex. Each year the fixed preferential tariffs for *new* qualifying renewable electricity plants are revised in downward direction in line with the projected technology specific generation costs. Feed-in tariffs in 2009 range from 0.08 €/kWh (onshore wind: first 5 years) up to 0.43 €/kWh for solar PV electricity.

The EEG grants additional preferential treatment to qualifying renewable electricity generators apart from preferential prices. Except for emergency situations and voluntary curtailment agreements, system operators are required to accept all power fed into their grid by qualifying renewable generators. When congestion problems occur, this can force competing generators to reduce their output (part-loading) or they may even have to stop the generation process altogether. Especially base-load generators may have to shoulder significant economic costs. Moreover, fossil-fuel-based generators forced to run in part-load emit more CO_2 and other pollutants as against running their plant in full-load mode. Furthermore, the EEG mandates system operators to absorb all imbalance impacts occasioned by qualifying renewable generators and to pass the associated costs on to, eventually, the electricity users. Conversely, competing generators are required to match their production to ex ante notified production plans and to pay the net settlement costs of any imbalances.

Grid operators are required to connect all renewable generating plants without regard for locational planning. Cost of network reinforcements have to be socialized. This applies for network reinforcement costs occasioned by all generating plants. Yet the network reinforcement costs are higher per kWh for intermittent renewable generators, after a certain fairly low penetration rate (capacity of intermittent renewable generating capacity as a % of peak demand in a certain network sub-system) is reached. The additional network integration cost rise more than proportionally with increasing penetration of intermittent renewable generation. The preferential grid integration treatment to qualifying renewable operators is prompted amongst others by the fact that the effective unbundling process is still to be completed. Unfinished effective unbundling could indeed seriously hamper grid access by independent renewable generators (foreclosure by incumbent integrated power companies).[11]

It is sometimes argued that a major part the additional cost of the German FIT system are offset from a societal point of view by the downward impact of intermittent renewables, notably onshore wind, on the power prices. This relates to the low short-term marginal cost of onshore wind which, in the margin, replaces options with higher short-term marginal cost such as electricity from CCGT (Combined Cycle Gas Turbine) plants and sometimes even from PCC (pulverised coal combustion) plants. Yet, under prevailing market conditions, the long-run marginal cost of the latter technologies tend to be lower. Hence, the long-run impact of the fast penetration of current-vintages onshore wind on electricity prices are rather opposite. Of course, another issue is the impact of fast deployment of onshore wind on technical learning. This impact might indeed be benign on realising cost reductions for future vintages of onshore wind turbines.

[11] By contrast, this issue has been addressed quite well in the Netherlands with ownership unbundling of both the high-voltage transmission network as well as the distribution networks from commercial activities regarding electricity generation, wholesale trade and retail supply.

The costs of the EEG-mandated feed-in tariffs, as well as the balancing costs for the system operators in whose network system qualifying renewable electricity was fed, are eventually passed on to largely small-scale electricity users. Large electricity users meeting certain requirements are exempted. The transfers of the feed-in tariffs and balancing costs associated with the EEG law are conducted through a horizontal and vertical cost equalisation procedure, which is administratively quite complex for the affected market actors, including system operators and electricity suppliers.

We proceed with a qualitative assessment of the performance of this support system for each of the selected criteria.

Environmental effectiveness. The German FIT system is widely credited for the fact that it engendered large expansions of renewable electricity capacity and volume. The open-ended generous tariffs have attracted renewable energy market players world-wide. Germany has more than doubled its renewable electricity production since 2000. The share of renewable electricity in total electricity production stands at 15% in 2008. It already exceeds the indicative target for 2010 of 12.5%.

Cost effectiveness. To date, the German feed-in tariff (FIT) system is under review for cost-reducing measures. The shielding of renewable generators from any market risks, yielding them stable cash flows containing normal to supra-competitive regulatory rents and open-ended approvals of high-cost technology such as *currently* solar PV is being perceived as increasingly less affordable for German society at large (Frondel et al., 2009). For the time being, some modest adjustments to market exigencies are considered by the German government with system reforms patterned on the ones implemented earlier in Spain. Initially, in Spain the option was offered to RES-E generators to choose between a fixed feed-in tariff without balancing risk and a fixed feed-in premium with balancing risk for the RES-E generator. Given the upward trend in electricity prices until 2008 RES-E generators massively chose the latter option, resulting in large windfall profits. The galloping cost of Spain's combined FIT/FIP (feed-in premium) system forced some recent reforms. A key reform feature regards the FIP option offered to renewable generators. To date, this option encompasses an ex post adjustment mechanism of premiums with some analogy to the ex post annual SDE tariff adjustments in the Dutch SDE support system.

The German feed-in tariff system scores rather low on cost effectiveness. The visible part of the price mark-up due to the feed-in tariffs mandated by the EEG amounted to 1.5 €ct/kWh in 2008 (Schiffer, 2009). This is about 7.5% of the average household electricity price. This *transparent* (!) mark-up part does not include the hidden cost of the EEG to power end-users, including:

- Higher system balancing costs occasioned by qualifying renewable generators compared to competing generators, reinforced by the absence of balancing responsibility for renewable generators
- Higher network costs due to the inefficiencies generated by the preferential network access treatment German TSOs have to grant qualifying renewable generators at zero use-of-system charges and with supra-shallow connection tariffs (e.g. for offshore wind), devoid of locational signals
- High deadweight administrative costs of horizontal (between the four German TSOs) and vertical (between TSOs and suppliers) cost equalisation of EEG tariff cash-outs and balancing costs, occasioned by priority access of renewable electricity in the complete absence of cost reflectivity
- Complete absence of downside price risk offered by EEG mandate to qualifying renewable generators, which boils down to a free-of-charge put premium offered - through force of law - by the other electricity system stakeholders. As during downswings in the macro-economic business cycles the electricity price tends to weaken, the additional cost of FIT to the consumer tend to increase during such phases. For the RES-E generators the opposite holds. Hence, the free-of-charge price risk premium denotes a hidden additional transfer to RES-E

generators. By comparison, SDE beneficiaries at least have to assume imbalance cost risk and a modest power price risk in the event of extreme downward price movements.

The overall macro-economic cost of the EEG for the German economy are substantial, also in terms of the net employment impact on the German economy (Jansen, 2003b; Frondel et al., 2009). A wealth of literature exists with claims, mostly on (methodologically) thin ice, that the German feed-in law is cost-effective. Typical methodological flaws include the neglect of hidden EEG cost, neglect of the long duration (20 years) of German EEG support compared to many other support systems, and - last but not least - inductive reasoning using the poorly-designed, cost-ineffective UK support system as prime benchmark. The same goes for the claims regarding beneficiary employment effects deriving from the EEG. Typically these claims are based on myopic consideration of gross direct employment only; at times in tandem with the dubious assumption that the opportunity cost of labour employed in the growing of bio-energy crops is naught.

It is sometimes argued that a major part the additional cost of the German FIT system are offset from a societal point of view by the downward impact of intermittent renewables, notably onshore wind, on the power prices (BMU, 2007; Sáenz de Miera at al., 2008). We do not buy this argument. It relates to the low short-term marginal cost of onshore wind which, in the margin, replaces options with higher short-term marginal cost such as electricity from CCGT (Combined Cycle Gas Turbine) plants and sometimes even from PCC (pulverised coal combustion) and nuclear power plants. Yet, under currently prevailing market conditions, the long-run marginal cost of the latter technologies tend to be lower. Hence, the long-run impact of the fast penetration of current-vintages onshore wind on electricity prices are rather opposite. Of course, another issue is the impact of fast deployment of onshore wind on technical learning. This impact might indeed be benign to realising cost reductions for future vintages of onshore wind turbines.

Impact on Government budget. There is no (direct) impact on the government budget. The FIT-cost and power system regulation cost of FIT-supported electricity are passed on to the small and medium-scale end-users through a complex administrative process.

Affordability. The German EEG system is less affordable for German society as already explained under the criterion cost effectiveness. As a result, reforms seem to be in the offing.

Compatibility with the current SDE system. The German system is virtually incompatible with SDE. In principle, renewable generators could be offered the option to either SDE or German-like open-ended FIT, the so-called Optional Bonus Model (Langniß et al., 2009) which has been pioneered by Spain. Yet apart from the potential risk for galloping support system cost, adopting the German administrative procedures and removing balancing responsibility for renewable generators like in Germany will cause great implementation problems for the Dutch electricity supply sector.

System stability. The German feed-in law has a relatively long history. Yet, system stability is not completely ensured because of the affordability issue. Moreover, legal challenges are not completely without risk regarding system stability (see below).

Fair competition. The German system has introduced strong pro-renewable-generation biases to the detriment of other electricity sector stakeholders:

- *Total protection of qualified generators against competition from other Member States*. Regulatory support competition between Member States can have strong market distortion impacts with Member States creating comparative support advantages instead of comparative advantages on sound economic basis. For instance, regarding the fast deployment of offshore wind learning by doing can be accelerated by capitalising much more on the economics of scale of the size of the EU market through harmonisation of support mechanisms.

- *Total shielding of any price risk*. This market distortion on account of environmental protection would seem more than proportionate.
- *No balancing responsibility*. This feature boosts system integration cost much more than would be the case with renewable electricity penetration any how. Negatively affected stakeholders: system operators, end users through higher hidden cost on their bills.
- *Priority access*. In combination with the previous feature this quite negatively affects competing generators, notably the ones with poor ramping flexibility for technical and/or economic reasons. The combination of this and the previous feature also hampers the introduction of innovative grid operation practices. Smart grids are essential for running grids with very high penetration of intermittent renewables. Hence, the strongly biased grid operation rules are **not** favourable for the development of intermittent renewables in regions where they have acquired high market shares. It can therefore be expected that in the medium run these distortions prompted by the EEG but also by recent EU legislation such as the Renewables Directive 2009/28/CE are up for revision.

Opportunities to support innovative technology. A fairly high rating on innovation is given: technological learning is stimulated by propitious market deployment. On the other hand, some regulatory rents which pamper renewable generators are passed on to German renewable generator equipment manufacturers.[12] Only when the German market gets saturated - accelerated by the flocking into the lavishly supported German market of foreign competitors - spoiled German equipment manufacturers are genuinely incentivised to introduce cost-reducing innovation. This is e.g. the case with wind turbine manufacturer Enercon that around year 2000 could rely for 100% of its production on the German market but was forced to implement major efficiency improvements and cost-reducing innovations later on to be able to successfully penetrate export markets when the German market got too crowded. A similar pattern can currently observed in the German PV panel manufacturers like Q-Cells that could quickly expand in Germany in terms of both profits and turnover. Now it endures fierce competition from East-Asian competitors such as Chinese company SunTech. To date, on account of the EEG German electricity users subsidise more jobs in the Chinese solar PV industry than in German itself (Frondel et al., 2009). It remains to be seen if the apparent success of the German industrial policy regarding the currently flourishing German onshore and offshore wind industry will sustain: the Chinese and Indian wind power industry is rapidly taking off.

Legal challenges. The jurisdiction of famous EJC verdict against E.ON in 2001 (European Court of Justice, 2001) and the new Renewables Directive[13] provide scope for new litigation in the ECJ with less certain outcome.

Scope for European harmonisation. The potential for EU-wide harmonisation on the basis of the German EEG is naught. The German Ministry for the Environment, BMU, has sponsored several large conferences and research to promote dissemination of FIT all over the EU. So far, this merely yielded some scant ‘best practices’ recommendations (Ragwitz et al., 2009).

3.4 Replace the SDE by an a supply-side RPS

A renewable portfolio standard (RPS) in the electricity market of a country or a region imposes an obligation on either *the demand side* (e.g. in most cases to electricity suppliers/retailers only or, alternatively, suppliers as well as large electricity users) or on *the supply side* (i.e. to electricity generators and electricity importers) to produce or deliver to their electricity end-use customers a certain minimum percentage of electricity from qualifying renewable sources. Usually renewable electricity sources that can compete in the market without any support, e.g. large-

[12] A tendency of local authorities approving permits of wind farm developers, to informally favour developers using German-made equipment and greater familiarity of German wind farm developers with German equipment are factors contributing to a trickling down of regulatory rents.

[13] Notably the compatibility of the ‘statistical transfers’ concept with European Law might prompt litigation.

scale hydro plants, are excluded. An RPS is also referred to as Renewables Obligation system or Quota-based system.

In most cases, RPS systems are backed up with a tradable renewable energy certificate (TREC) system. TRECs are issued to qualifying renewable electricity generators. Generally one certificate is issued for each MWh that was generated by a qualifying source, e.g. by wind power operators.[14] The generators concerned can sell the certificates to market participants that have RPS compliance obligations or, if applicable, use these certificates themselves. Hereafter we assume that TRECs are always used to provide evidence of compliance with the prevailing RPS standard by obligated market participants. We also assume that all RPS certificate market participants use a dedicated electronic RPS certificate tracking system operated by a competent authority: CertiQ under supervision of Energiekamer in the case of the Netherlands.

A supply-side renewable portfolio standard (RPS) is imposed on generators and importers of electricity: each generator/importer of electricity are required to make sure that the total quantity of electricity that he generates in or imports into the country concerned in a certain year contains a certain minimum percentage of electricity from qualifying renewable sources. *So far the only country or region applying a supply-side RPS to date is Italy*.[15] Reasons for the lack of appetite for supply-side RPS support systems include: (1) problems to import electricity with a credible renewable nature as this requires harmonised certification and cross-border trading of the 'green certificates'; (2) less flexibility to exempt electricity-intensive companies with high exposure to international competition because of the upstream character of this measure.[16] Besides, Renewable Directive 2009/28/EC prompts a demand-side rather than a supply-side RPS as it prescribes targets for the Member States on the share of renewables in final energy *demand*.

As for all measures with an RPS system considered in this report, we assume that the demand-side RPS includes a certification system for the qualifying renewable electricity. One tradable renewable electricity certificate (TREC) is assumed to be issued to the qualifying generator for each MWh of output. Furthermore, we assume a good system design. Such a design is based on an ambitious but realistic long-term plan of electricity demand and the potentials for expanding generation of electricity from qualifying sources. Based on projected expansion of renewable electricity and overall electricity supply, a transparent and ambitious but realistic scheme is designed, providing certainty to investors on the evolution of the target over a long period of time (at least 10-15 years). For the measure under consideration we assume that no supplementary technology-specific support will be offered to qualifying generators.

The performance of the system on the distinct criterion aspects is explained hereafter.

Environmental effectiveness. Depending on well-conceived system design features, the measure can achieve a high extent of target compliance. The expansion of electricity from qualifying renewable sources with a well-designed RPS is not likely to fully match the effectiveness of a German-type feed-in-tariff system. Even so, with adequate system size, sufficiently high penalties, adequate flexibility features (such as a certain extent of banking) and other design features as well as good complementary implementation measures a good target compliance can be en-

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14 Recent legislation in the UK has recently introduced the option for the regulator of the UK RPS system to change the number of certificates per unit of relevant electricity in a bid to mitigate some weaknesses in the pre-existing UK RPS system (See Appendix B for more details). This deviates from standard practice, which is reflected in our assumption.

15 Again, reference is made to Appendix B. It contains a brief description of *inter alia* the Italian RPS system. Italy is on the verge of a transition from a supply-side RPS support system to a demand-side one.

16 The supply-side RPS imposes the burden of compliance on generators and importers of electricity. In the absence of detailed regulations how to pass on this burden on particular end-user categories, the upstream actors in the electricity supply chain will include the RPS costs in their margins in bilateral or spot market trades of the wholesale electricity market. This way, the RPS costs are passed on to all electricity users. This can be compared to the difference between an upstream carbon tax and a carbon emission trading system. Because of the mid/downstream character of the latter, energy-intensive manufacturers can exempted more easily compared to a carbon tax system.

forced. In U.S. states with a good RPS system design such as the one run by ERCOT in Texas (very close to) 100 % target compliance is the rule. To date, in Europe the (demand-side) Swedish RPS system has a reasonable system design, resulting after a brief teething period at the start a good target compliance record and relatively low certificate prices (See Appendix 2). Key is that the RPS design will yield a stable or gradually rising TREC price in line with the growing scarcity of investment opportunities in renewable low-additional-cost resources. To the extent, that the supply-side RPS design does not rely on projected imports of renewable electricity, the effectiveness of well-designed supply-side and demand-side systems will be similar.

Cost effectiveness. The Dutch supply curve for renewable electricity is rather steep: the potential for renewable electricity from low/medium-additional-cost sources is limited in the Netherlands. A 'one-size-fits-all' RPS system (i.e. without making allowance for different cost characteristics of the various qualifying technologies) with ambitious targets - requiring substantial extra renewable electricity consumption over and above the RES-E consumption in the absence of this system - is likely to result in high TREC price. Either the cost of electricity in excess of the wholesale base-load electricity price (€/MWh) for high-cost marginal renewable energy technology, or the penalty for under-compliance (€/MWh), determines the TREC price evolution. Substantial free riding can be expected by operators of qualifying renewable electricity generating plants with relatively low generating costs. The cost of supported renewable electricity of the 'one-size-fits-all' support measure will therefore be relatively high and the cost-effectiveness inversely low. We note that lately Italy has introduced technology banding to make better allowance for technology-specific diversity in generation costs: see Appendix B.

Impact on government budget. As the market parties with RPS obligations have to ensure compliance with the standard, in principle, an RPS system is budget-neutral, contingent on the destination of penalty payments for under-compliance. If these transfers will be earmarked as a source of general government revenues ('greening the fiscal system'), the impact on the public finance situation will be positive in the event of significant under-compliance.

Affordability. The Netherlands has relatively limited endowments of cheap renewable potentials. Relatively cheap potentials with, in practice, strong limitations include onshore wind and certain biomass technologies, such as the biodegradable fraction of municipal waste and biomass co-incineration. To achieve a 35% renewable electricity target in 2020 in the absence of international trading opportunities for target compliance, the Netherlands has to resort for a large part to high-cost sources such as offshore wind. In the absence of complementary technology-specific measures, a relatively high total amount of windfall profits is captured by renewable generators using low-cost renewable resources. Ultimately, electricity users have to pay. Hence, the RPS support system for electricity suppliers scores low with regard to affordability.

Compatibility with the current SDE system. In principle, a supply-side RPS is very well compatible with the prevailing SDE system. Yet as in the present case, the SDE is supposed to be dismantled, the measure considered is assigned a low score on this criterion aspect.

System stability. We do not hold high expectations of system stability as the affordability and fair competition issue (see below) will give rise to much criticism and unrest in the public domain.

Fair competition. The potentials for renewable electricity from cheap renewables are very limited in the Netherlands. The lucky operators that control these potentials and related third parties, such as land owners of good onshore wind sites, can capitalise on windfall profits in the form of resource rents. In contrast, generators having to resort to high-cost renewables as no low renewables potentials are left (i.e. because of 'crowding out' of low/medium-additional-cost potentials), are in a disadvantageous competitive position. This case will also adversely affect the gener al business environment as also the electricity using business sector will face significantly higher electricity prices.

Opportunities to support innovative technology. As the RPS system considered is of a 'one-size-fits-all' variety, technologies considered innovative can not be given special market deployment support. Only very high, and thus unaffordable, TREC prices will stimulate high-cost innovative technology. As the cost of such a market deployment policy will be prohibitively expensive the support system under review scores very low on market innovation.

Legal challenges. Given the equity and fairness issues (windfall profits, poor affordability; and no level playing field in renewable electricity generation) the system considered might well be facing serious legal challenges.

Scope for European harmonisation. Sooner or later the currently 27 renewable electricity markets in the EU, almost completely closed for competition originating from market operators in other MS, will be opened as a result of evolving new EU legislation: either by the normal legislative process or by intervention from the European Court of Justice. Yet the 'one-size-fits-all' character of the current case and the consequent high windfall profits makes it less suitable for European harmonisation. The high windfall profits would seem at odds with the Community Guidelines on State Aid for Environmental Protection (European Union, 2008a: page 19, guideline 107). Moreover, if harmonisation on the basis of an RPS were to be the case, the Renewables Directive would prompt a demand-side RPS rather than a supply-side RPS. This and some practical implementation drawbacks mentioned above as well as the tendency among countries with an RPS to opt for a demand-side system further weaken the scope of a supply-side RPS for European harmonisation.

3.5 Replace the SDE by a demand-side RPS

In the present case, we assume that the Dutch SDE (feed-in premium) system will be replaced by an RPS for suppliers[17] and large electricity users.[18] We assume that the government aims for a broad coverage, including large users, to foster environmental effectiveness, equal treatment of all electricity-using companies, and to deepen the market (high market liquidity). To the extent that electricity-intensive users are highly exposed to international competition exemptions might be considered. In principle, only qualifying 'new capacity' established after the start of the RPS would be entitled to TRECs. It might be considered to entitle existing plants up to a certain extent as well to TRECs for a transitional period to kick-start the TREC market. Each obligated actor has to administer to the RPS competent authority, Energiekamer, or a third party supervised by the competent authority, e.g. CertiQ, a sufficient number of TRECs certificates to meet the RPS target. For the Netherlands the standard can e.g. be set at 35 % of renewable electricity in year 2020.[19]

Furthermore, we assume the absence of a systemic penalty recycling mechanism, such as the one in the UK Renewables Obligation system. Penalty payments for under-compliance could for instance be used as a source for general central government revenues or replenish a fund for renewable energy RD&D activities.[20]

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17 Note that the conventional term 'supplier' is a bit confusing. It stands for a company whose business it is to procure electricity from the wholesale power market or through own production and to sell it to its customers, i.e. to final electricity users.

18 Large electricity users, such as for example Corus and TenneT tend to buy electricity needs in excess of electricity (possibly) generated from own generating plants either directly or through an intermediary trader on the wholesale market, e.g. through tender procedures.

19 Note that appropriate target setting is to be based on detailed analysis of supply and demand conditions in the TREC market: (too) low targets will provide little stimulation to expand RES-E generating capacity, (too) high targets can lead to surging TREC prices. This in turn may render the support system less affordable or may lead to target under-compliance, or both.

20 A built-in penalties recycling mechanism negatively affects cost effectiveness of RPS systems and can provide perverse incentives towards overall incompliance in an oligopolistic electricity retail markets, served by a few large integrated suppliers (owning at the same time sizable portfolios of generating assets). The Great Britain RPS system with six large integrated suppliers serving virtually the whole market is a case in point. See Appendix B.

We proceed with a qualitative assessment of the performance of this support system for each of the selected criteria.

Environmental effectiveness. In principle, with adequate system size, sufficiently high penalties, adequate flexibility features (such as a certain extent of banking) and other design features a good target compliance can be enforced. In U.S. states with a good RPS system design such as the one run by ERCOT in Texas (very close to) 100 % target compliance is the rule. In Europe, several countries with an RPS system are experiencing less good results due to poor system design, e.g. the UK Renewables Obligation system (See Appendix B for more details). To date, the Swedish RPS system is the one with the best system design in Europe with after a brief teething period at the start a good target compliance record (See also Appendix B). We note that, in terms of the total volume of qualifying renewable electricity, the Dutch RPS system as assumed in the present case is of an almost comparable size as the current Swedish system.[21]

Cost effectiveness. A 'one-size-fits-all' RPS system (i.e. without making allowance for different cost characteristics of the various qualifying technologies) with ambitious targets - requiring substantial extra renewable electricity consumption over and above the RES-E consumption in the absence of this system - is likely to result in a high average TREC price. Either the cost of electricity in excess of the wholesale base-load electricity price (€/MWh) for the (high-cost) marginal renewable energy technology, or the penalty for under-compliance (€/MWh) determine the TREC price evolution. This leads to substantial windfall profits for operators of qualifying renewable electricity generating plants with much lower generating costs. The cost of supported renewable electricity will therefore be relatively high and the cost-effectiveness inversely low.

Impact on government budget. As the market parties with RPS obligations have to ensure compliance with the standard, in principle, an RPS system is budget-neutral, contingent on the destination of penalty payments for under-compliance. If these transfers will be earmarked as a source of general government revenues ('greening the fiscal system'), the impact on the public finance situation will be positive in the event of significant under-compliance.

Affordability. The Netherlands has relatively limited endowments of cheap renewable potentials. Relatively cheap potentials with, in practice, strong limitations include onshore wind and certain biomass technologies, such as the biodegradable fraction of municipal waste and biomass co-incineration. To achieve a 35% renewable electricity target in 2020 in the absence of international trading opportunities for target compliance, the Netherlands has to resort for a large part to high-cost sources such as offshore wind. In the absence of complementary technology-specific measures, a relatively high total amount of windfall profits is captured by renewable generators using low-cost renewable resources. Ultimately, electricity users have to pay. Hence, the RPS support system for electricity suppliers scores low with regard to affordability.

Compatibility with the current SDE system. In principle, a suppliers-based RPS is very well compatible with the prevailing SDE system. Yet as in the present case, the SDE is supposed to be dismantled, the measure considered is assigned a fairly low score on this criterion aspect.

System stability. We do not hold high expectations of system stability as the affordability and fair competition issue (see below) will give rise to much criticism and unrest in the public domain.

Fair competition. The potentials for renewable electricity from cheap renewables are very limited in the Netherlands. The lucky operators that control these potentials and related third par-

[21] One of the reasons for notable windfall profits generated within the RPS system of Flanders is its small system size. See Appendix B for more details on the Flemish RPS system.

ties, such as land owners of good onshore wind sites, can capitalise on windfall profits in the form of resource rents. In contrast, generators having to resort to high-cost renewables as no low renewables potentials are left (i.e. because of 'crowding out' of low/medium-cost potentials), are in a disadvantageous competitive position. This case will also adversely affect the general business environment as also the electricity using business sector will face significantly higher electricity prices.

Opportunities to support innovative technology. As the RPS system considered is of a 'one-size-fits-all' variety, technologies considered innovative can not be given special market deployment support. Only with extremely high standards (say, 50% renewable electricity) the RPS certificate price will go through the roof, stimulating high-cost innovative technology. As the cost of such a market deployment policy will be prohibitively expensive the support system under review scores very low on market innovation.

Legal challenges. Given the equity and fairness issues (windfall profits, poor affordability; and no level playing field in renewable electricity generation) the system considered might well be facing serious legal challenges.

Scope for European harmonisation. Sooner or later the currently 27 renewable electricity markets in the EU, almost completely closed for competition originating from market operators in other MS, will be opened as a result of evolving new EU legislation: either by the normal legislative process or by intervention from the European Court of Justice. Yet the 'one-size-fits-all' character of the current case and the consequent high windfall profits makes it less suitable for European harmonisation. The high windfall profits would seem at odds with the Community Guidelines on State Aid for Environmental Protection (European Union, 2008a: page 19, guideline 107).

3.6 Introduce a demand-side RPS in combination with the SDE

A demand-side RPS and the SDE support system have been described in Sections 3.5 and 3.2 respectively. The RPS system should be designed such that - at least in the initial stage - the relevant competent authority is mandated to use flexible market intervention instruments to ensure that the TREC price remains within a certain projected bandwidth. Generally, the RPS target should be set at a level that the system imposes a binding constraint so that the RPS certificates assume significant minimum value, e.g. above 10 €/certificate. Yet the target should not be set so stringent as to raise the certificate above the standard cost (i.e. under 'average' Dutch renewable resource conditions) of the cheapest qualifying renewable electricity option with a relatively large potential, i.e. e.g. onshore wind. This is to minimize windfall profits. Then, the SDE support mechanism will in an approximate fashion level the playing field for all qualifying renewable generation technologies. This way the SDE support mechanism in combination with the RPS system will minimize windfall profits more than the SDE already does at present on a stand alone basis.

The reason is that the RPS triggers cost-reducing competition, i.e. not only between generators within one particular SDE category but also between generators falling in different SDE categories on account of the RPS mechanism. This is applicable to the extent that the TREC market is a competitive market. The Dutch electricity wholesale market is fairly concentrated (NMA/Energiekamer, 2008a). Yet the Dutch supply-side of renewable electricity is much more diversified than Dutch electricity supply as a whole. This is brought about by a fairly diversified with a major share of a large number of small independent producers on top integrated companies such as RWE (Essent), Vattenfall (Nuon) and Eneco.[22] On the demand side a number of

[22] Once wind offshore takes off really hard this may result on more concentration on the supply side. On other hand, the offshore wind business attracts also new players to the Dutch electricity and TREC market along with the established large players.

new entrants such as Electrabel, E-oN, Centrica (Corio) and smaller niche players have triggered more competition on the Dutch electricity retail market with gradually more diversification although the market share by the three incumbents RWE (Essent), Vattenfall (Nuon) and Eneco is still high (NMa/Energiekamer, 2008b). Evidently, regarding the TREC market, market concentration is an issue warranting close attention (See also Koutstaal et al., 2008; van Tilburg et al., 2007). Furthermore, we suggest an RPS / SDE system, which includes an ex post adjustment mechanism of the SDE premium for the recent evolution of the electricity price, input-fuel price *and* the TREC price. Ex post adjustment of SDE subsidy rates for recorded TREC prices provides some further safeguard against windfall profits.

Another point of attention is encompassed by the Community Guidelines on State Aid for Environmental Protection. These stipulate that (justified) SDE support on top of an RPS is allowed for a period of 10 years (European Union, 2008a: page 20, guideline 110 (b)).

The performance of the measure on the distinct criterion aspects is analysed hereafter.

Environmental effectiveness. In principle, the hybrid RPS-SDE system merges the best of both systems in isolation. The closed-end nature of the SDE, coupled to a flexible RPS with an ambitious target along with an adequate enforcement regime[23] permits high certainty of target completion compared to other support systems, without significant under- nor overshoot. Note that in principle the SDE makes due allowance for different cost characteristics for the distinct qualifying renewable generation technologies.

Cost effectiveness. Barring unexpected, very large, drops in the wholesale electricity price the support system under consideration is due to perform slightly better than the SDE. This results from the more competitive nature of the hybrid system. In the SDE system the plant operators of one single SDE-defined technology have a joint interest in strong political lobbying for a ‘fair’ (i.e. highly remunerative) SDE premium which does not prompt fierce cost competition. Fierce cost competition between project developers applying a certain SDE technology can lead to more than average profits once the SDE cost base has been fixed for a certain vintage. At the same time this might result in a fixing of much lower SDE premium for newer vintage plants, which is not in the interest of SDE-supported project developers. Yet in the hybrid system, a smaller part of the the cash flow of a project developer is determined by the SDE premium: on top of the commodity price, it also depends on the TREC price. SDE beneficiaries of all SDE technologies together influence the TREC price. In a large TREC market without players that can exercise significant market power project developers cannot influence the TREC price. In such a business environment, project developers face more cash flow uncertainty. Their strategic behaviour is likely to be more focused on cost reduction. This feature improves the cost effectiveness of RPS-SDE versus SDE only.[24]

In the event of unexpectedly severe downward pressure on the electricity price, the SDE premium may not cover the full projected cost gap. In the hybrid system, though, the SDE beneficiaries will be more or less fully compensated as the TREC price will show an almost perfectly opposite, i.e. upward price evolution. Hence, on the one hand the hybrid RPS-SDE system of-

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23 Such a regime includes notably a penalty rate at a level slightly above the level of the generation cost of the marginal electricity unit upon target completion, subtracted by (1) the applicable SDE premium and (2) the average base-load electricity price.

24 In the literature on renewables support mechanism, proponents of feed-in tariff systems put much emphasis on the impact of uncertainty by investors regarding the TREC price on raising the required rate of return of investors, referring to the British case (e.g. Redpoint, 2008). Acknowledging that even with well-designed RPS systems this is the case to some extent, we like to point out the failure of these and many other analysts comparing the UK support system with the German FIT system to apportion in a quantitative fashion the lion’s share of the low cost effectiveness of the UK support mechanism to idiosyncratic design features of the UK system on boosting windfall profits such as notably the penalties recycling mechanism as well as to other UK-specific barriers such as sticky permitting procedures. The latter hinder the realisation of onshore wind projects in the UK appreciably more than in many other EU countries including notably Germany.

fers even more cash flow stability to RES-E project developers than the SDE system alone already provides. This is an attractive feature for project developers. On the other hand, this feature of complete absence of *ex post* downward revenue risk per unit of production in the hybrid system compared to the pure SDE system reduces the cost effectiveness of RPS-SDE versus SDE only.

As price drops of the average annual electricity price below one third of the anticipated long-term price development are presumably rare events, the competitiveness feature of the RPS-SDE system is likely to dominate over the absence of downward revenue risk feature. On balance, the cost effectiveness of the hybrid RPS-SDE system is likely to be slightly higher than the pure SDE system.

Impact on government budget. As the market parties with RPS obligations have to ensure compliance with the standard, in principle, an RPS system is budget-neutral, contingent on the destination of penalty payments for under-compliance. If these transfers will be earmarked as a source of general government revenues ('greening the fiscal system'), the impact on the public finance situation will be positive in the event of significant under-compliance. A shift in the financing model of the SDE from government budget allocations to contributions imposed upon the end users is under preparation .

Affordability. Referring to the analysis of the cost effectiveness of an RPS-SDE system above, the affordability of this system will be at least comparable to the SDE system or slightly higher.

Compatibility with the current SDE system. As the SDE is fully integrated in the RPS-SDE system, the compatibility is perfect.

System stability. Given the favourable performance on other criteria, including environmental effectiveness and affordability, the system stability is expected to be high.

Fair competition. The RPS-SDE system mimics a normal competitive market to the higest extent of all support systems considered in this report. It is more competitive than the SDE system, and at the same time on appreciably fairer terms than the pure RPS system, where those project developers with access to scarce low/medium cost potentials can cash in high windfall profits at the expense of the electricity end users.

Opting for the broadest RPS coverage would negatively affect the business entities that are exposed to international competition. This negative impact can be mitigated by excluding electricity-intensive manufacturing companies meeting certain criteria, e.g. in a similar fashion as exemptions are made for certain German establishments for the EEG mark-up on the electricity price. Also the level of ambition in target setting might be slightly moderated so as to bring down the TREC price to a slightly lower level.

The RPS system might provide hurdles to small-scale renewable operators. This might be mitigated by fully socializing the cost of CertiQ for running the electronic platform. These transparent cost disclosed in CertiQ's annual reports are dwarfed by e.g. the hidden administrative cost that the German electricity sector has to incur regarding EEG compliance, which are socialised as well, if in an opaque fashion.

Opportunities to support innovative technology. The RPS-SDE system gives comparatively ample opportunity for learning by doing as the SDE system. The stronger competition element in the former system will favourably impact the willingness of project developers to take risk of operational failures by investing in new technology that is anticipated to reduce cost compared to reliable conventional technology.

Legal challenges. The market-based nature of the RPS-SDE system and its favourable performance on a broad set criteria including fair competition, the robustness to legal challenges is expected to be high.

Scope for European harmonisation. Sooner or later the currently 27 renewable electricity markets in the EU, almost completely closed for competition originating from market operators located in other MS, will be opened as a result of new EU legislation: either by the normal legislative process or by intervention from the European Court of Justice. Adoption of the system considered places the Netherlands in a *front runner* position to capitalise on the great gains of trade benefits from the unavoidable trend towards European harmonisation of national support systems.

3.7 Impose a generic CO_2 standard on power plants

Serious discussions are ongoing in the Dutch political arena to impose a CO_2 emissions standard on operators of coal-fired power plants. This would introduce the obligation to generators, applicable to each power plant in isolation - to reduce CO_2 emissions down to a level of at most 350 grams of CO_2/kWh CO_2. In practice, this regards coal fired power plants and to a lesser extent generating plants used only during peak demand periods. Competing generation technology such as notably CCGC (combined cycle gas combustion) already tends to meet this standard. The motivation for the measure is in general to transform our economy into a low carbon direction or in particular to boost CCS (carbon, capture and storage).

The consequences of such a measure might be either one of the following for the operator of a particular coal-fired plant, that is negatively affected by the measure:

1. The operator absorbs the negative impact on his future cash flow and takes the necessary technical adjustment measures (assuming that this is feasible any how) and will buy e.g. the necessary palm oil from South-East Asia or wood-based pellets from Canada obtained from energy-intensive pre-treatment and necessitating typically high-sulphur fuel-oil-based (i.e. CO_2 and other pollutants emitting) intercontinental transportation of the biomass feedstock.
2. The business sector does not anticipate that CCS will be technologically mature, let alone cost-competitive, in the period we consider in this report with a time horizon of year 2020. Yet when high enough - i.e. quite substantial - public funding from the national government and/or the EU can be secured for RD&D, application of CCS will be considered as well.
3. The operator discontinues operation. Litigation against the Dutch state will ensue on the liability for the stranded cost.

The performance of this regulation on the distinct criterion aspects is analysed hereafter.

Environmental effectiveness. The measure will stimulate one or more of the following options: i) more electricity imports; ii) demand reduction because of upward electricity price impact; iii) new natural-gas-based CCGT capacity; iv) biomass co-incineration; v) if high project- or technology-specific subsidisation can be secured: application of CCS; vi) new nuclear energy capacity; and vii) new renewable generation capacity. Options iv), vii), and indirectly ii) will foster the share of renewable electricity in meeting Dutch electricity demand. As options i) and iii) are likely to play a major role, the measure is a blunt, less effective instrument to promote the deployment of renewables.

The measure is at best a very blunt and probably counter-productive in promoting CO_2 reduction at the Member State, EU and global level respectively. The measure has zero effect on the CO_2 emissions of the European power sector, falling under the EU ETS. Yet the measure leads to replacement of relatively cheap market-based CO_2 reduction in the ETS by this more expensive CO_2 reduction option. Furthermore, investment in (typically less energy-efficient) coal-fired power plants elsewhere in Europe and worldwide (carbon leakage) will be incentivised on account of supra-national management of the company portfolio of generating assets by large generating companies and the negative impact on prices of internationally traded hard coal and the EU carbon market price.[25]

For the Netherlands, the impact on the direct subsidy cost of reaching the renewables target is ambiguous in principle but likely to be positive. The negative impact on the carbon price and the positive impact on the electricity price (directly through reduced or more expensive availability of baseload capacity and indirectly through the positive impact on the natural gas price) offset each other to an uncertain extent. Yet as the positive impact on the electricity price is poised to dominate, the direct subsidy cost of reaching the renewables target would become less. This positive effect is dwarfed by the indirect costs through reduced consumer surplus on account of high electricity prices, which is much higher than the consequent increased producer surplus for Dutch low-CO_2 generators.

Cost effectiveness. Firstly, as explained in the preceding paragraph, the measure will raise the societal cost of GHG emissions reduction. Second, each of the three options available to operators of coal-fired power plants will have a significant upward effect on the electricity price. Third, as explained further above the instrument is rather blunt for promoting renewable electricity deployment. In conclusion, the performance of the instrument on cost effectiveness is extremely poor.

Impact on Government budget. There is no (direct) impact on the government budget.

Affordability. Referring to the analysis of the performance of the instrument on the environmental effectiveness and the cost effectiveness criteria, the affordability of this measure relative to more efficient measures to achieve deployment of renewable electricity is very low.

Compatibility with the current SDE system. The measure can be implemented jointly with the SDE system.

System stability. Referring to the negative impacts on affordability and fair competition, the performance with regard to the system stability criterion is low.

Fair competition. The measure would change the rules of the game with quite adverse consequences for the competitiveness of a particular sub-category of generators only.

Opportunities to support innovative technology. The measure fosters co-incineration and CCS, which are transitional, not particularly innovative technologies towards long-term solutions to de-carbonise the economy. Moreover, the measure inhibits market-based flexibility to negatively affected operators towards cost-effective carbon emissions reduction and thus stimulation of cost-reducing environmental technology innovation.

Legal challenges. The measure is at odds with fair competition and less compatible with internal market rules, as it would distort the competition between players in different Member States. Furthermore, the environmental protection aims, intended to be achieved by the measure, can be obtained at much lower societal costs: see the analysis regarding environmental and cost effectiveness above.

Scope for European harmonisation. In principle, the measure could be applied EU-wide. Yet, given the adverse impacts on fair competition between players using different generating tech-

[25] If the proposed measure is implemented in the Netherlands only these price effects are small indeed. If implemented EU-wide these effects are certainly not negligible.

nologies, environmental effectiveness and cost effectiveness of the measure, EU-wide adoption is highly unlikely.

3.8 Impose a biomass co-firing standard on coal power plants

Serious discussions are ongoing in the Dutch political arena to impose a biomass co-firing standard on operators of coal-fired power plants, e.g. the obligation for coal-fired power plant operators - applicable to each coal-fired plant - to generate at least 40% of the total output on the basis of biomass. The measure aims to reduce the adverse GHG-emissions impact of coal-fired power plants or, alternatively, to trigger their operators to switch them into permanent idleness. A second consideration is that biomass co-incineration is a relatively cheap measure to achieve the mandatory Dutch target regarding the share of renewables in final energy consumption. The measure is to be implemented on top of existing regulations, such as the SDE support mechanism.

The consequences of the measure might be either one of the following options for a certain coal-fired plant, affected by the measure:

1. The operator absorbs the negative impact on his future cash flow and takes the necessary technical adjustment measures (assuming that this is feasible any how) and will buy the necessary biomass feedstock overseas, obtained from energy-intensive pre-treatment and necessitating typically high-sulphur fuel-oil-based (i.e. CO_2 and other pollutants emitting) intercontinental transportation of the biomass feedstock.
2. The operator discontinues operation. Litigation with the Dutch state will ensue on the liability for the stranded cost. It boils down to replacement of relatively less expensive market-based CO_2 reduction measures in the EU ETS by this expensive measure. This measure will stimulate investment elsewhere in Europe and worldwide in - in general less energy-efficient - coal-fired power plants on account of supra-national management of the portfolio of generating assets by large international power generating companies and the negative impact on prices in internationally traded hard coal and the EU carbon market price.

The performance of this regulation on the distinct criterion aspects is explained hereafter.

Environmental effectiveness. The measure will stimulate one or more of the following options: i) biomass co-incineration; ii) more electricity imports; iii) demand reduction because of upward electricity price impact; iv) new natural-gas-based CCGT capacity; v) new nuclear energy capacity; and vi) new renewable generation capacity. Options i), vi), and indirectly iii) will foster expansion of the share of renewable electricity in meeting Dutch electricity demand. As the other options, notably new CCGT capacity, are likely to play a major role as well, the measure is a blunt, i.e. less effective instrument to promote the deployment of renewables.

The measure is at best a very blunt and probably counter-productive in promoting CO_2 reduction at the EU and global level. The measure has zero effect on the CO_2 emissions of the European power sector, falling under the EU ETS as the carbon emissions of all installations collectively are defined by the ETS target. It leads within the ETS to replacement of relatively low cost market-based CO_2 reduction by this expensive reduction measure. Also, investment in (typically less energy-efficient) coal-fired power plants elsewhere in Europe and world-wide will be incentivised on account of supra-national management of the company portfolio of generating assets by large generating companies and the negative impact on prices of internationally traded hard coal and the EU carbon market price.[26]

For the Netherlands, the impact on the direct subsidy cost of reaching the renewables target is ambiguous in principle but likely to be positive. The negative impact on the carbon price and

[26] See footnote 25.

the positive impact on the electricity price (directly through reduced or more expensive availability of baseload capacity and indirectly through the positive impact on the natural gas price) offset each other to an uncertain extent. Moreover, biomass co-firing is directly pushed by the proposed mandatory standard. As the latter effect and the positive impact on the electricity price is poised to dominate over the negative impact on the carbon price, the direct subsidy cost of reaching the renewables target would become less. This positive effect is dwarfed, however, by the indirect costs through reduced consumer surplus on account of high electricity prices, which is much higher than the consequent increased producer surplus for Dutch low-CO_2 generators.

Cost effectiveness. Firstly, as explained in the preceding paragraph, the measure will raise the social cost of GHG emissions reduction. Second, each of the three options available to operators of coal-fired power plants will have a significant upward effect on the electricity price. Third, as explained further above the instrument is rather blunt for promoting renewable electricity deployment. In conclusion, the performance of the instrument on cost effectiveness is rather poor.

We note that if - a big if[27] - coal power plants will stay in business and apply 40% biomass co-incineration at a large scale, the resulting renewable electricity can be counted towards the mandatory Dutch target of 14% renewables in year 2020. This *could* save on SDE expenditure for high-cost technology such as offshore wind, which - considered in isolation - is favourable for lowering the energy bill of Dutch electricity users. Yet the price for the biomass feedstock is set to surge towards unprecedented levels towards year 2020 in a scenario of GHG-emissions reduction policy programmes world-wide. This tendency will be reinforced by other EU-governments seeking to apply fast-working ad hoc measures to jack up their renewables share in final energy consumption towards target year 2020: measures such as notably biomass co-incineration. Hence, in order to entice operators to keep their coal-fired power plants open under application of 40% biomass co-firing the SDE subsidisation premium to bridge the cost gap for biomass co-incineration would need to be raised to high levels. Moreover, the adverse welfare effects as a result of higher power prices have to be factored in as well. Furthermore, regarding the cost effectiveness criterion not only static but certainly also dynamic efficiency needs to be considered. Biomass co-incineration is a less suitable option when really deep GHG emission cuts of 50% or more are required.

Impact on Government budget. There is no (direct) impact on the government budget.

Affordability. Referring to the analysis of the performance of the instrument on the environmental effectiveness and the cost effectiveness criteria, the affordability of this measure relative to more efficient measures to achieve deployment of renewable electricity is low.

Compatibility with the current SDE system. The measure can be implemented jointly with the SDE system.

System stability. Referring to the negative impacts on affordability and fair competition, the performance of the measure with regard to the system stability criterion is low.

Fair competition. The measure would change the rule of the game with quite adverse consequences for the competitiveness of a particular sub-category of generators only.

Opportunities to support innovative technology. The measure fosters co-incineration, which is a transitional, not particularly innovative technology towards long-term solutions to de-carbonise the economy. Moreover, the measure inhibits market-based stimulation of environmental innovation.

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[27] For quite a few large coal-fired plants technical limitations are rather stringent, inhibiting expansions of biomass co-firing to shares in excess of a maximum of about 20%.

Legal challenges. The measure is at odds with fair competition and less compatible with internal market rules, as it would distort the competition between players in different Member States. Furthermore, the environmental protection aims, intended to be achieved by the measure, can be obtained at much lower societal costs: see the analysis regarding environmental and cost effectiveness above.

Scope for European harmonisation. In principle, the measure could be applied EU-wide. Yet, given the adverse impacts on fair competition between players using different generating technologies, environmental effectiveness and cost effectiveness of the measure, EU-wide adoption is highly unlikely.

3.9 Impose a CCS obligation on coal-fired power plants

Serious discussions are ongoing in the Dutch political arena to impose an obligation to apply CCS (carbon, capture and storage) to each coal-fired power plant, once this technology is deemed be ready for implementation. This is to be implemented on top of existing regulations, such as the SDE support mechanism.

The motivation for the measure is in general to transform our economy into a sustainable, low carbon direction, and for certain proponents in particular to render low-carbon coal an alternative for new nuclear build. CCS is a technology that is practiced for advanced oil and gas recovery; whilst CO_2 has certain niche applications in industry and horticulture. Dedicated sequestration is so far demonstrated at a small-scale level, whilst currently RD&D projects are put in the pipeline to demonstrate it at a level necessary for application to (typically large-scale) power plants.

The promotion of CCS has strange bedfellows: on the one hand powerful vested interests in fossil fuel business and internal combustion motor technology for transport vehicles and, on the other hand, part of the environmental NGOs and environmentally-concerned politicians. In promoting public funding for CCS, among other the following claims tend to be made: (i) there is absolutely no risk of leakages at CO_2 storage facilities; (ii) upon a certain period of technical learning the additional social cost for application of CCS to coal-fired power generation upon technological maturity are on the order of €35 (US$ 50) / t CO_2; (iii) the resulting carbon emissions reductions are on the order of 85-90% of without CCS carbon emissions. To date, each of these three claims is contested within the scientific community. For the purposes of this assessment we assume that all these claims will be vindicated.

The consequences of the proposed measure in the event that no legally enforced revocation will be either one of the following for the operator of a particular coal-fired plant, affected by the measure:
1. The operator absorbs the negative impact on his future cash flow and takes the necessary technical adjustment measures (assuming that this is feasible any how).
2. The operator discontinues operation.

The performance of this regulation on the distinct criterion aspects is explained hereafter.

Environmental effectiveness. The measure will stimulate one or more of the following options: i) application of CCS (only if sufficiently high project- or technology-specific subsidisation can be secured on top of public support through the EU ETS); ii) more electricity imports; iii) demand reduction because of upward electricity price impact; iv) new natural-gas-based CCGT capacity; v) new nuclear energy capacity; and vi) new renewable generation capacity. Option vi) and, indirectly, iii) will foster the share of renewable electricity in meeting Dutch electricity demand. As the other options, notably i) and iv) are likely to play a far more important role, the measure is a blunt, ineffective instrument to promote the deployment of renewables.

The measure is at best a blunt instrument to promote CO_2 reduction at the EU and global level. The measure has zero effect on the CO_2 emissions of the European power sector, falling under the EU ETS. This expensive CO_2 reduction measure will replace cheaper market-based ones within the EU ETS. Also, investment in (typically less energy-efficient) coal-fired power plants elsewhere in Europe and worldwide will be incentivised on account of supra-national management of the company portfolio of generating assets by large generating companies and the negative impact on prices of internationally traded hard coal and the EU carbon market price.[28]

For the Netherlands, the impact on the direct subsidy cost of reaching the renewables target is likely to be positive. The negative impact on the carbon price and the positive impact on the electricity price (directly through reduced or more expensive availability of baseload capacity and indirectly through the positive impact on the natural gas price) offset each other to an uncertain extent. Yet as the positive impact on the electricity price is poised to dominate, the direct subsidy cost of reaching the renewables target would become less. This positive effect is dwarfed by the indirect costs through reduced consumer surplus on account of high electricity prices, which is much higher than the consequent increased producer surplus for Dutch low-CO_2 generators.

Cost effectiveness. Firstly, as explained above, the measure will raise the social cost of GHG emissions reduction in the ETS sector. Second, each of the two options available to operators of coal-fired power plants will have a significant upward effect on the electricity price. Third, as explained above the instrument is in ineffective instrument for promoting renewable electricity deployment. In conclusion, the performance of the instrument on cost effectiveness is extremely poor.

Impact on Government budget. There is no (direct) impact on the government budget.

Affordability. Referring to the analysis of the performance of the instrument on the environmental effectiveness and the cost effectiveness criteria, the affordability of this measure relative to more efficient measures to achieve deployment of renewable electricity is very low.

Compatibility with the current SDE system. The measure can be implemented jointly with the SDE system.

System stability. Referring to the negative impacts on affordability and fair competition, the performance with regard to the system stability criterion is low.

Fair competition. The measure would change the rule of the game with quite adverse consequences for the competitiveness of a particular sub-category of generators only. Moreover, under the proposed measure CCS can crowd out better alternatives from a climate change policy perspective. This applies in particular to generators mulling investment opportunities in new coal+CCS power generation capacity in relation to investments in power generation alternatives with appreciably lower GHG reduction cost than CCS.

Opportunities to support innovative technology. The measure fosters CCS, i.e. a transitional, not particularly innovative technology towards long-term solutions to de-carbonise the economy.

Legal challenges. The measure is at odds with fair competition and less compatible with internal market rules, as it would distort the competition between players in different Member States. Furthermore, the environmental protection aims, intended to be achieved by the measure, can be obtained at much lower societal costs: see the analysis regarding environmental and cost effectiveness above.

[28] Again, these price effects will be more notable if applied on an EU-wide basis instead of just in the Netherlands.

Scope for European harmonisation. In principle, the measure could be applied EU-wide. Yet, given the adverse impacts on fair competition between players using different generating technologies, environmental effectiveness and cost effectiveness of the measure, EU-wide adoption is unlikely.

3.10 Measure ratings per criterion and on overall performance

In this concluding Section performance ratings for each considered measure are presented. For each measure respectively simple ratings are allotted per criterion from 1 (very negative) through 5 (very positive). The rating of the overall performance of the distinct measures results from calculating the un-weighted average of all criterion scores.

Again, it is emphasised that the allotted scores are based on subjective judgments by the author, as justified by the qualitative analysis in Sections 3.2 - 3.9 above. In fact, the simple aggregation rule applied top arrive at the total score of a case - tacitly presuming that all criteria are equally important - is intrinsically subjective. This aggregation rule is used for want of a robustly better one.

On aggregate, the performance of the current SDE system scores quite well relative to most of the proposed new measures.

Table 3.2 *Qualitative assessment of regulatory and support measures for renewable energy target compliance on distinct criterion aspects*

Support measure	Involved (Dutch) actors	Envir. effectiveness	Cost effectiveness	Impact Gov. Budget	Affordability	Compatible with SDE	System stability	Fair competition	Support innovative technology	Legal robustness	Scope for European harmonisation	Σ/n 1)
Baseline												
Current SDE	RES-E generators	4	3	3	2	5	3	3	4	3	4	3.4
Proposed measures												
German FIT	RES-E generators	5	2	3	1	1	2	1	4	2	1	2.2
Supply-Side RPS	Generators + importers	4	1	3	1	1	1	2	1	2	1	1.7
Demand-Side RPS	Suppliers + certain end-users	4	1	3	1	1	1	2	1	2	2	1.8
Demand-Side RPS + SDE	Ditto + RES-E generators	4	4	3	3	5	4	4	5	5	5	4.2
CO2 standard	Power plants	2	1	3	1	5	2	1	2	2	2	2.1
Biomass co-firing standard	Coal-fired power plants	2	1	3	1	5	2	1	2	2	2	2.1
CCS obligation	Coal-fired power plants	2	1	3	1	5	2	1	1	2	2	2.0

1) Overall performance: unweigted average of criterion ratings

Rating legend:

5 : very positive (favourable) impact on criterion aspect / positive impact compared to baseline development by a large extent
4 : fairly positive (favourable) impact on criterion aspect / positive impact compared to baseline by a moderate extent
3 : neutral impact on criterion aspect / neutral impact compared to baseline development
2 : fairly negative impact on criterion aspect / negative impact compared to baseline development by a moderate extent
1 : very negative impact on criterion aspect / negative impact compared to baseline development by a large extent

Source: expert judgment by the author.

4. Conclusions and recommendations

4.1 Conclusions

In this study a selection of measures to foster the share of renewables and the reduction of carbon emissions in the Dutch electricity sector have been subjected to a preliminary qualitative assessment. The main conclusions follow hereafter.

The current SDE system. The current SDE is performing better than all support systems tried out so far in the Netherlands. According to our findings it also performs better than most proposals currently discussed within the Dutch political arena. Its strong points compared to most other support mechanisms are environmental effectiveness, support to innovative technology, and scope for European harmonisation. Not unlike other mechanisms if to diverging extent, a trade-off exists between environmental effectiveness and affordability: effective RES-E policy costs much additional money! At least in the short to medium run. To achieve a 35 % renewable electricity share by 2020, the SDE budget will surge because a very high recourse has to be made on high-cost renewable electricity potentials. This is likely to meet with increasing resistance from electricity end-users and politicians. Meeting sub-targets consistent with the Dutch renewable energy commitments enshrined in EU legislation will be increasingly challenging. Hence, further improving cost effectiveness of RES-E support is poised to be a focal point of public attention.

Replace the SDE by the German-type feed-in system. It scores very high on environmental effectiveness, especially market deployment of technology with a very high cost gap but very poor on affordability, fair competition and compatibility with European harmonisation. In the German system renewable generators are shielded from any risks against reaping competitive-like to supra-competitive regulatory rents. Moreover, open-ended approvals of high-cost technology, such as (*currently*) solar PV, are increasingly perceived to be less affordable for the German society at large. To date, some modest adjustments to improve affordability are considered with system reforms likely to be patterned on the ones implemented earlier in Spain.

Replace the SDE by a supply-side RPS. Overall this support system scores low. In particular, it scores weak on criteria such as affordability, system stability and innovation. With the ambitious RPS targets in accordance with the Dutch renewable energy targets, the measure is poised to generate large windfall profits. The reason is that this measure does not differentiate between the technology-specific cost features of commercially immature RES-E technologies. Yet for achieving the ambitious RPS targets consistent with Dutch government commitments much use has to be made of high-additional-cost renewable electricity potentials, notably offshore wind. This will imply high certificate prices. In turn, high windfall profits are poised to accrue to generators that have the privilege to rely on scarce low/medium-additional-cost renewable electricity potentials, e.g. onshore wind and possibly (if biomass feedstock prices will not rise too much) biomass co-incineration. A supply-side RPS as compared to a demand-side RPS has some practical implementation drawbacks and has less scope for European harmonisation.

Replace the SDE by a demand-side RPS. The conclusions about the previous measure, a supply-side RPS without complementary support, apply to a single demand-side RPS as well. Again with the exception that a demand-side RPS has some implementation advantages to a supply-side one, such as the virtual impossibility to date to import renewable electricity, the difficulty to grant exposed electricity-intensive companies a waver and more scope for co-operation with other Member States on (more efficient) renewable electricity support.

Introduce a demand-side RPS in combination with the SDE. This system tends to embody the best performing features of both sub-systems in isolation. As a result, it is the only proposed measure with a better overall rating than the current SDE. None of the measures considered here excels in affordability, given the trade-off between environmental ambitions and cost-effectiveness. Yet this measure has the potential to be most cost-effective of all. It will trim off a major part of the expenditure on SDE system, as the revenues for SDE-supported RES-E generators will be factored in the ex post determination of the SDE subsidy rate. This way, their revenues per MWh will be stabilised. On the other hand, by keeping the SDE in place the competitive playing field of operators using RES-E technologies with different cost gaps is broadly levelled, as distinct from an RPS in isolation. Given a reasonably functioning TREC market, this will trigger cost-reducing competition. Moreover, ex post adjustment of SDE subsidy rates for recorded TREC prices provides some further safeguard against windfall profits. An advantage for project developers, as against SDE in isolation, is the full coverage of the combined RPS+SDE support against steeply falling electricity prices. Moreover, the RPS-SDE system will place the Netherlands in an excellent position to profit from the gains from cross-border trade, once a certain form of harmonisation of support mechanisms by (either a few bottom-up or all top-down) EU Member States will take shape.

A generic CO_2 standard imposed on power plants. In the event coal-fired plant operators will go for the biomass co-firing they may import wood pellets from Canada or biofuels from South-East Asia. Within the EU ETS sector, less expensive market-based CO_2 reduction measures are replaced by this more expensive measure. Should the measure lead to stranded coal assets this measure will undermine the EU ETS without any impact on emissions within the EU ETS system. It also gives incentives for carbon leakage. As this proposed measure for implementation in the Netherlands is (quite) distortionary and quite negatively affecting the competitive position of specific categories of Dutch participants in the EU ETS without affecting carbon emissions in the EU power sector at all, this poses a strong basis for those stakeholders to seek legal rejection of the measure at the national level. Implementation at EU level is unlikely given the poor environmental and cost effectiveness of such a measure, including the stimulation of carbon leakage.

Biomass co-firing standard on coal-fired power plants. Almost the same holds as for a plant-specific CO_2 standard. Due to surging biomass feedstock prices, SDE support tariffs may have to be increased. Still, at least in the very short term this measure may render renewable target achievement somewhat easier. Availability of 'sustainable' biomass will be increasingly problematic.

CCS obligation on coal-fired power plants. Broadly the same holds as for the previous two measures. At best the measure is modestly effective in reducing CO_2 emissions at plant level when considering the whole life cycle from fossil fuel extraction to carbon storage. From a European environmental perspective, this measure is again undermining the EU ETS. If in the absence of such EU ETS undermining measures EU policy makers decide to tighten the carbon emissions limit down to a sufficiently low level, this rises the carbon price to levels whereby the competitive position of coal-fired power plants will make it commercially impossible to continue 'business as usual'. Then operators of such plants will have to make a commercial trade-off between: (i) going for biomass co-firing; (ii) going for CCS; (iii) discontinuing operations. At the same time, the EU and its Member States can realise carbon emission reductions at lowest costs. The more the societal bill for carbon emissions reduction will rise, the more politically imperative it will become in western-democratic societies to achieve carbon reductions at lowest cost.

4.2 Recommendations

Results of our qualitative analysis suggest that introducing within the coming few years of a demand-side RPS *in combination with the current SDE* deserves serious public consideration.

Should this measure be adopted, the development of a well-designed RPS from the very start of the scheme is of paramount importance. Details have to be spelled out such as choice of qualifying sources, the extent of participation of existing qualifying plants, long-term projections of qualifying gross and net new capacity, long-term projections of electricity from qualifying sources in relation to evolving electricity demand, target setting over a long period, compliance flexibility and enforcement arrangements, and the integration of the TREC price in the ex post SDE subsidy adjustment mechanism. Moreover, the due political and legislative trajectory has to be completed. A prudent fast-track introduction is therefore likely to take about three years.

The advantages of a Dutch demand-side RPS / SDE support scheme in achieving the quite ambitious and likewise expensive Dutch renewables targets set at lowest societal cost will increase substantially by international co-operation. Sweden would be the most attractive partner in this respect with high mutual benefits to be gained. Hence, in designing a demand-side RPS / SDE scheme early contacts with the appropriate Swedish authorities are recommended to make to scheme compatible with the Swedish support scheme to a major extent.

Also the possibilities for collaboration with the Belgium Regions, in particular Flanders, can not be discounted off hand. Moreover, upcoming changes in the Italian RPS system may open up new collaboration opportunities. In spite of major practical problems, also here significant mutual benefits from cross-border trade can be gained.

The environmental effectiveness and/or cost effectiveness of a range of proposed measures, intended to boost the share of renewables and to reduce GHG emissions in the Dutch power sector is very poor. In this regard, we mention in particular proposals to impose additional standards, aimed directly or indirectly at coal-fired power plants. We have assessed in this regard the imposition of respectively CO_2 standards, biomass co-firing standards, and/or a CCS obligation. These measures seriously undermine the functioning of the EU ETS, the prime instrument to impose carbon emissions reductions *at lowest societal cost* by economic actors participating in this scheme.

Dutch coal-firing generators are participating in the EU ETS. Imposing all sorts of additional carbon-reduction measures on Dutch coal-fired power plants is of no avail to achieving any reduction of carbon emissions at all. On the other hand, these measures substantially reduce the flexibility of the affected actors to meet their ETS obligations in the most cost-effective way. The economic damages of the measures concerned sustained by these actors will transpire through the Dutch economy by means of higher wholesale and end-user electricity prices.

References

BMU (2007): *Renewable energy sources in figures - national and international development - national and international development.* German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. Environmental Policy Series. Public Relation Division. Berlin.

CBS (2009): *Renewable energy in the Netherlands 2008*. The Hague/Heerlen.

Egenhofer, C., J.C. Jansen (2006): *'A timetable for harmonisation of support schemes for renewable electricity in the EU'*. European Review of Energy Markets. Vol. 1(2). 57-63

European Court of Justice (2001): *Judgment in Case C-379/98, Preussen Elektra AG v Schleswag AG*. ECR I-2099. 13 March 2001

European Union (2008a): *Community Guidelines on State Aid for Environmental Protection*, O J C 82/1, Brussels, 1 April 2008

European Union (2008b): *Consolidated version of the Treaty on the functioning of the European Union*, O J C 115/47, Brussels, 9 May 2008

European Union (2009): *Directive2009/28/EC of the European Parliament and the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.* O.J. L 140/16. Brussels. 5 June 2009

EZ (2009): *Betreft Beantwoording kamervragen, gesteld tijdens AO van 3 maart jl.* Letter of Dutch Minister of Economic Affairs to Lower House of the Dutch Parliament. ET/ED/ 9072297. The Hague. 17 April 2009

Frondel, M., N. Ritter, C. Vance (2009): *Economic impacts from the promotion of renewable energies: The German experience.* RWI Projectbericht. Final report. Rheinisch-Westfälisches Institut für Wirtschaftsforschung. Essen.

GSE (2008): *'Incentivazione delle fonti rinnovabili con il sistema dei Certificati Verdi'.* Bollettino al 30 giugno 2008.

GSE (2009): *'Incentivazione delle fonti rinnovabili con il sistema dei Certificati Verdi'.* Bollettino al 30 giugno 2009.

IEA (2004): *RENEWABLE ENERGY: Market & Policy Trends in IEA Countries*. OECD/IEA, Paris

IEA (2008): *DEPLOYING RENEWABLES; Principles for Effective Policies*. OECD/IEA, Paris

Jansen, J.C. (2003a): *'A green jewel box?'*. Environmental Finance. March 2003 issue, 27

Jansen, J.C. (2003b): *Policy support for renewable energy in the European Union: A review of the regulatory framework and suggestions for adjustment*. Report-I—03-002. ECN, Petten. October 2003.

Jansen, J.C., M.A. Uyterlinde (2004): '*A fragmented market on the way to harmonisation? EU policy-making on renewable energy promotion'*. Energy for Sustainable Development. Vol. VIII (1). 93-107

Jansen, J.C, K. Gialoglou and C. Egenhofer (2005): *Market Stimulation of Renewable Electricity in the EU: What Degree of Harmonisation of Support Mechanisms if Required?* CEPS Task Force Report No. 56: CEPS, Brussels; http://www.ceps.eu/book/market-stimulation-renewable-electricity-eu-what-degree-harmonisation-support-mechanisms-requir

Klessmann, C. (2009): *'The evolution of flexibility mechanisms for achieving European* *renewable energy targets 202 - ex-ante evaluation of principle mechanisms'*. Energy Policy. Article in Press

Klein, A. *et al* (2008): *'Evolution of different feed-in tariff design options - Best practice paper for the International Feed-in Cooperation'*. Research paper sponsored by BMU. 2nd edition. Fraunhofer Institute Systems and Innovation Research, Karsruhe, October 2008

Koutstaal, P., M. Bijlsma, G. Zwart, X. van Tilburg, Ö. Özdemir (2008): *Market performance and distributional effects on renewable energy markets*. CPB Document No 190. CPB. The Hague.

Langniß, O., J. Diekmann, U. Lehr (2009): *'Advanced mechanisms for the promotion of renewable energy - Models for the future evolution of the German Renewable Energy Act'*. Energy Policy. Vol. 37. 1287-1297

Linden, N.H. van der, M.A. Uyterlinde, C. Vrolijk, K. Ericsson, J. Khan, L.J. Nilsson, K. Astrand and R. Wiser (2005): *Review of international experience with renewable energy obligation support mechanisms*, Report ECN-C--05-025, The Energy research Centre of the Netherlands, Petten, May.

Lipponen, J. (2009): *'Flexible friends'*. Renewables. Point Carbon. Oslo. 24 April 2009

McKinsey (2008): *'The economics of solar power'*. The McKinsey Quarterly. June 2008

NMA/Energiekamer (2008a): *Monitoring energiemarkten 2007*. The Hague. September 2008

NMA/Energiekamer (2008b): *Marktmonitor Nederlandse kleinverbruikersmarkt voor elektriciteit en gas; juli 2007 - juni 2008*. The Hague.

Palmer, K., D. Burtraw (2005): '*Cost-effectiveness of renewable energy policies*'. Energy Economics. Vol. 27, 873-894

Poletti, C. (2009): *Certificati Verdi: novità normative della Legge Sviluppo.* , Centre for Research on Energy and Environmental Economics and Policy, Bocconi University.

Ragwitz, M. *et al* (2007): *Asssessment and optimisation of renewable energy support schemes in the European electricity market: Final report*, Fraunhofer Institute Systems and Innovation Research, Karlsruhe, February 2007

Ragwitz, M., P. del Río, G. Resch (2009): *'Assessing the advantages and drawbacks of government trading of guarantees of origin for renewable electricity in Europe'*. Energy Policy. Vol. 37. 300-307

Redpoint (2008): *'Impementation of the EU 2020 Renewable target in the UK Electricity Sector: Renewable Support Schemes'*. Version vI.0. 23 June 2008

Sáenz de Miera, G., del Rio Gonzáles, P., Vizcaíno, I. (2008): '*Analysing the impact of renewable electricity support schemes on power prices: the case of wind electricity in Spain'*. Energy Policy. Vol. 36. 3345-3359

Schiffer, H.W. (2009): *'Deutscher Energiemarkt 2000'*. Energiewirtschaftliche Tagesfragen. Vol. 59 (3), 52-66.

Segers, R. (2008): *'Three options to calculate the percentage renewable energy: An example for a EU policy debate'*. Energy Policy. Vol 36, 3243-3248

SenterNovem (2006): *Protocol Monitoring Duurzame Energie*. Version of year 2006. 2DEN-06.11. SenterNovem. Utrecht.

Sijm, J.P.M., O.J. Kuik, M. Patel, V. Oikonomou, E. Worrell, P. Lako, E. Annevelink, G.J. Nabuurs, H.W. Elbersen (2004): *Spillovers of Climate Policy*. Report 500036 002. NRP-CC programme. Bilthoven. December 2004

Swedish Energy Agency (2008): *The electricity certificate system, 2008*. Stockholm.

Tilburg, X. van; J.C. Jansen; M.A. Uyterlinde; S. M. Lensink (2007): *Verplichting voor duurzame elektriciteit in Nederland. Verkenning van mogelijkheden en randvoorwaarden.* Report ECN - E -- 06-038 (in Dutch). ECN, Petten. March 2007

Verbruggen, A. (2009): *'Performance evaluation of renewable energy support policies, applied on Flanders' tradable certificate system'*. Energy Policy. Vol. 37, 1385-1394.

Verbruggen, A., V. Lauber (2009): *'Basic concepts for designing renewable electricity support aiming at a full-scale transition by 2050'*. Energy Policy. Article in press.

VROM (2007): *Nieuwe energie voor het klimaat. Werkprogramma Schoon en Zuinig*. Ministry of housing, spatial planning and the environment (VROM). The Hague. September 2007

Werring, L. (2008): '*Targets and markets are not enough'*. European Energy Review. July/August 2008 issue, 48-51

Appendix A The method to calculate the share of renewables matters for targets and policies!

The Government Agreement of the Balkenende IV Administration and its Clean and Efficient climate policy package mention an indicative target of 20% renewables (i.e. energy from renewable sources) in the Dutch energy mix of year 2020. This target diverges from the (mandatory) target spelled out for the Netherlands in year 2020 regarding the share of renewables in EU Directive 2009/28/2009 not merely in the specified percentage point value. *They also diverge in accounting unit.* [29]

The Dutch Bureau of Statistics, CBS, compiles national energy statistics using the so-called *substitution method* of the Protocol Monitoring Renewable Energy. The leading principle of this method is the potential use of primary fossil fuels[30] that is replaced by a renewable energy source. This method has some major advantages compared to other methods, the most important one being that it substantially mitigates the biases against certain sources of notably electricity from ambient renewable sources (i.e. hydro power, wind power, solar, geothermal, marine energy resources). For instance, in the method predominantly used in international statistics by e.g. IEA and Eurostat, the *primary energy method*, counts a kWh of electricity from a biomass or fossil fuel source, or nuclear power plant applying an estimated or notional energy conversion factor, which may lead to a primary energy supply volume on the order of 9 - 15 MJ (10^3 joules). Yet for the same unit of electricity, kWh, but this time from hydro, wind, solar or marine resources no losses of primary energy stores in fossil sources occur and this unit of electricity is accounted for by the primary energy method at its mere calorific value of 3.6 MJ.

Apart from differences between assumed conversion factors and actual conversion factor, with regard to accounting for 1 kWh of electricity generation the substitution method does not lead to discrimination according to source. The energy value of 1 kWh of electricity use from an ambient renewable energy source is up-rated from 3.6 MJ by an imputed standard primary fossil fuels substitution factor e.g. 2.5 yielding an energy value of 9. Yet for 1 MJ calorific value biodiesel and bio-gasoline (bio-ethanol) much less corresponding primary fuel (crude oil) is being replaced due to conversion losses. Table 2.1 below reproduces the primary fossil fuels substitution factors proposed by Reinoud Segers for international energy statistics when these are to be compiled on the basis of the substitution method.[31]

29 Reinoud Segers has presented insightful further explanations of energy accounting issues in amongst other (Segers, 2008).

30 Also the replacement of nuclear. Yet this relates to the debatable current practice to value 1 kWh produced by a nuclear power plant at its heat input value. This current practice blows up the weight of nuclear relative to electricity generated from ambient renewable sources.

31 See (Segers, 2008) for further explanation of the values in Table 2.1.

Table A.1 *Proposed factors for applying the substitution method to convert one joule of final renewable energy into the corresponding joules multiple of standard primary conventional energy*

	Factor
Electricity	2.50
Solar thermal energy	1.00
Derived heat	1.00
Final use of solid bionass in households	0.75
Biodiesel	0.70
Biogasoline	0.35
Final use of biomass, excluding transport fuels and solid biomass in households	1.00
Final use of geothermal heat	1.00

Source: Segers, 2008.

A disadvantage of using the substitution method in international energy statistics is that the actual average conversion factor for the same energy conversion technology, e.g. pulverised coal combustion for electricity generation, varies among countries and within countries among power plants. This would warrant the use of standard notional conversion factors for distinct energy conversion technologies. Moreover, conversion factors tend to change over time: new plants typically embody more energy-efficient technology, whilst after commissioning in the absence of major overhauls energy efficiency may slightly deteriorate. This would call for periodic updating of standard notional conversion factors. On the other hand, technological developments would also warrant periodic updating of notional conversion factors used by the primary energy method for international statistics.

The recent Renewables Directive 2009/28/CE has introduced and mandated a third method for compiling renewable energy statistics for target accounting purposes, the so-called *final energy-consumption method*.[32] The leading principle of this method is the heating-value-based energy content of 'energy commodities' delivered to final consumers for delivering energy services (industrial process and space heating/cooling; electric energy services; and transportation). Final energy consumption, as defined by the Renewables Directive, includes transmission and distribution losses ex final energy conversion plant that produced energy commodities (heat, electricity) delivered to end-users. Yet it excludes energy conversion losses and energy losses on account of extraction and transportation of input fuels to final energy conversion plants as well as energy conversion losses of pre-treatment. Furthermore, it discriminates against electricity. Final application of a certain quantity of fossil or biomass fuels is counted much less when using it for power generation than when it would be used for provision of useful heating/cooling or, to a lesser extent[33], for transport fuels.

In line with the substitution method, the final energy consumption method does not by and large discriminate electricity generation with regard to source. Yet the energy accounting value of 1 kWh of electricity, irrespective of source, is put at the heating-based energy value of 3.6 MJ. An exception is made for electricity used in electric vehicles. The Renewables Directive seeks to stimulate the use of electricity in transport. For this particular application, 1 kWh of electricity counts 2.5 times more, i.e. 9 MJ.[34] This can be justified, indeed, by reference to replacement of crude oil.[35] A Member State is offered the choice between two parameters to calculate the re-

32 *De facto*, the wording energy consumption is incorrect as according to the First Law of Thermodynamics no energy is produced nor gets lost. 'Energy use', or rather: 'fuel use' and/or 'electricity use' is more appropriate.

33 Especially when applying biomass resources for biofuels discrimination against electricity is less compared to using it for end-use heating purposes.

34 This exception is *only* applicable to the compliance accounting for the EU 10% renewable automotive transport fuels target: it does *not* apply for the overall EU 14% renewables target, which the Netherlands is mandated to meet by 2020.

35 To a certain extent it can also be justified by the well-to-wheel energy-efficiency advantages of electric vehicles.

newable fraction of this 9 MJ: either the renewable share in the EU energy mix or the renewable share in the national energy mix. Member States such as the Netherlands with a relatively poor renewable resource base (no large hydro potential) will opt for the EU renewables share, whilst the high-renewables countries will opt for the national renewables share. Hence a certain volume of electricity used by electric vehicles in a high-renewables Member State contributes more to its national and, by implication, the EU renewables target than the same volume used for the same purpose in a low-renewables Member State.

Both the substitution method and the primary energy method allow for the use of fossil fuels and biofuels in non-energy applications, notably for industrial feedstock. This feedstock is used for production of e.g. plastics (petrochemical industry) or urea (fertilizer industry). The final energy consumption method of the Renewables Directive does not make any allowance of fuel use in industrial feedstock.[36]

The main conclusion from the above is that the choice of energy numéraire can matter a great deal. The accounting method of the Renewables Directive introduces strong biases:

- pro renewables for heating and transportation final use as compared to renewable electricity
- pro use of electric vehicles in Member States with a well-endowed renewables resource base
- no accounting at all for non-energy final use of (biomass and fossil) fuels.

Hence, use of a certain quantity of biomass for heating and, to a lesser extent, transportation counts more towards renewable target. Hence the Renewables Directive - in contrast with recent GHG legislation - tends to dissuade the use of biomass in electricity. This applies *a fortiori* for the use of biomass in industrial feedstocks. Compared to final energy consumption method mandated by the Renewables Directive the substitution method provides appreciably better insights into the contribution of renewables to greenhouse gas emissions reductions and security of supply (lessening the dependence on fossil fuels).

The 14% renewables target in *final* energy consumption for the Netherlands is a firm mandatory commitment enshrined in the EU Directive 2009/28/EC. Irrespective of the Dutch government coalition in office in year 2020, the Dutch government is held to comply with this mandatory target. Upon under-compliance the Dutch government is liable to potentially expensive infringement procedures imposed by the European Commission. Dutch society has to put up the bill for support measures needed for target achievement. Several expert projection exercises put this bill for Dutch society over the period 2010 - 2020 *tentatively* at around *€ 30 billion*. Given this high burden, it would appear sensible to implement intelligent renewables support measures that keep total support cost as low as possible *whilst achieving environmental targets*, notably on renewables and Greenhouse Gases (GHG) emissions reduction. We note that in principle the broad nature of intelligent support measures do not depend on the stringency of environmental targets, *unless (some of) these targets can be met without extra policies*. This is certainly not the case for the Netherlands regarding its 2020 EU targets for GHG reduction and the share of renewable energy in final energy consumption: robust additional policies have to be put in place to comply with these Dutch EU targets. In the next section we give some further details on the EU renewable energy commitments for the Netherlands.

[36] This is clearly at odds with energy policy integration with regard to the three primordial energy policy goals. Neglecting the potential for replacement of fossil fuels by renewables in industrial feedstock may negatively affect supply security and to a certain extent GHG emissions abatement policy as well.

Appendix B Key features of selected RPS market support mechanisms within the EU

Currently among the 27 EU Member States most States have opted for a feed-in tariff or feed-in premium system as main support mechanism for the deployment of renewable electricity. To date, 7 States have opted for an RPS as main support system, i.e. Belgium (i.e. the three Belgium Regions including Flanders, each of which with an own design), Latvia, Italy, Romania, Poland, Sweden, and the UK. With the exception of the Latvian RPS, all the RPS systems concerned use a TREC certificate system for compliance flexibility and compliance enforcement purposes.

Note that in most Member States the main RES-E support mechanism is supplemented with other support measures, e.g. broad-based fiscal facilities such as tax depreciation allowances or specific support for currently quite- high-additional-cost (in need of substantial support) or quite-low-additional-cost technology (in need of just a last small push).

In this Annex a preliminary description is made of essential design features of the RPS support systems of Flanders, Italy, Sweden and the UK respectively. Flanders, Sweden and the UK have implemented a demand-side RPS. Italy sets, to our knowledge, the single exception of RPS systems world-wide with a supply-side RPS. Sweden boasts the best performing RPS in the EU; whilst for the purposes of this study the RPS of Flanders is among others interesting because of its proximity to the Netherlands. The UK and Italy rank among the largest EU economies, each of which with a rather unique RPS design: the UK's RPS with a penalties recycling mechanism and Italy's RPS being supply-side based.

Given time and resource constraints, this overview is based on a relatively quick (if still labour-intensive) scan of literature and relevant websites. Within the confines of the present project, we were able to find most but not all details we wished to retrieve. Hence the conclusions are of a preliminary nature. Nonetheless, we think some useful lessons can be drawn from the information presented.

B.1 Flanders

Introduction
Belgium is a federal state with a large extent of autonomy of its three Regions: Flanders, Wallonia and Brussels. Flanders has implemented a demand-side RPS since 2002. Obligated market actors, i.e. electricity retail suppliers, are to ensure that a certain minimum proportion of the electricity they deliver was generated by qualifying renewable sources. To that effect they have to submit for cancellation to VREG, the agency overseeing the Flemish RPS, a sufficient number of TRECs, called *groencertificaten* or green certificates. Obligated actors can buy these certificates directly or indirectly from qualifying renewable generators, to which VREG issues TRECs in line with the electricity volume they generated. The target for obligated suppliers is set to increase gradually from 0.8% in 2002 to 13% in 2020.

Qualifying sources and entitlement period
In Flanders generation of renewable electricity is mainly supported by the Flemish RPS. Qualifying renewable generators can trade the TRECs issued to them. Alternatively, the RES-E generators can submit their TRECs to the network operator for a guaranteed price, e.g. 450 €/MWh to date for solar PV. The guaranteed price is different for each category of qualifying source and changes in accordance with the periodic updates of the projected of the additional RES-E cost for each category compared to the electricity market price. Moreover, wind offshore does not

fall under the competence of the Flemish regional government. For this option specific support is offered by the federal government of Belgium. Qualifying sources for the Flemish RPS include:

- Wind onshore
- Biomass, subdivided into many subcategories with different guaranteed TREC prices and TREC entitlement periods
- Small hydro power (plants with a capacity < 10 MW)
- Tidal and wave power
- Geothermal
- Solar PV

Except for biomass co-firing, each of these sources qualifies for one TREC per MWh if with price guarantees and entitlement periods varying per RES-E category. Qualified generation also counts for entitlement to certificates, when the electricity concerned is used for own needs. Yet non-renewable energy use for running the power plant itself and for pre-treatment of biomass feedstock of the renewable power plant is excluded. Details on guaranteed minimum TREC prices and entitlement period per RES-E category for installations commissioned from 2010 onwards are shown in Table A.2 hereafter.

Table B.1 *Flanders: guaranteed prices of TRECs and entitlement period per qualifying RES-E category for installations commissioned in year 2010 or later (in Dutch)*

bijstook van vaste of vloeibare biomassa in kolencentrales			60€/MWh gedurende 10 jaar
biogas uit vergisting van restafval, afval- of rioolwaterzuivering(sslib)			
verbranding van restafval			
niet vermelde technieken			
vaste of vloeibare biomassa			**90€/MWh gedurende 10 jaar**
biomassa-afval			
niet vermelde biogas			
waterkracht			
getijden- en golfslagenergie			
aardwarmte			
windenergie-op-land			
zonne-energie	**2010**	**350€/MWh**	**gedurende 20 jaar**
	2011	330€/MWh	
	2012	310€/MWh	
	2013	290€/MWh	gedurende 15 jaar
	2014	250€/MWh	
	2015	210€/MWh	
	2016	170€/MWh	
	2017	130€/MWh	
	2018	90€/MWh	
	2019	50€/MWh	
	2020	10€/MWh	

Source: Vlaams Energieagentschap.

To date, co-firing of biomass fuel in coal-fired power plants running up to 60% on biomass entitles to only 0.5 certificates per MWh of biomass-based RES-E. Transport energy used for imported biomass is deducted from the amount of qualifying biomass-based RES-E unless it originates from renewable sources (*Besluit van de Vlaamse regering van 5 maart 2004 inzake de bevordering van elektriciteitsopwekking uit herniewbare bronnen - officieuze coördinatie: Art11*). Reason for the entitlement to half the normal number of certificates is that the current additional cost of this RES-E option are estimated by the Flemish regulator to be on the order of 40 €/MWh with a certificate price hovering around 105 €/MWh. Hence, this way the Flemish regulator seeks to limit windfall profits for generators using the co-firing option.

Certificate price guarantees are also granted by the federal government to offshore wind (107 €/MWh for first 216 MW installed and 90 €/MWh thereafter); onshore wind and hydro power (50 €/MWh) solar power (150 €/MWh); other RES-E (20 €/MWh). These guaranteed prices are applicable for a period of 20 years from the date of commissioning in the case of offshore wind and 10 years for the other technologies. Evidently it depends on expected prospective market circumstances as to whether RES-E project developers opt to sell their TRECs or offer these to transmission network operator, Elia, or the relevant distributed network operator for the relevant guaranteed minimum price. Disbursements by network operators to RES-E operators based on guaranteed minimum certificate prices are socialised in the end-user electricity tariffs. The guaranteed certificate prices seek to bolster investor confidence.

Coverage of electricity end-users

Only end-users served by retail suppliers are affected. End-users connected to the transmission network who buy electricity directly on the wholesale market are excluded as are transmission and distribution network operators (i.e. procurements to balance T&D losses and for the provision of ancillary services). Suppliers delivering to end-users with an annual demand in excess of 20,000 MWh are exempted on their RPS obligation for a certain part of these deliveries. Also use of electricity generated on site is exempted. Hence on site generation for own use is stimulated this way in combination with qualification of certain RES-E categories for TREC issuing.

Target evolution

The envisaged target evolution, as it stands to date, is shown in Table A.3 below. The share of qualifying renewable sources in electricity demand by obligated actors is set to more than double in the coming ten years.

Table B.2 *Set targets for the Flemish RPS, 2002-2020*

Year	Target [%]	Year	Target [%]
2002	0.80	2012	8.00
2003	1.20	2013	9.00
2004	2.00	2014	10.00
2005	2.50	2015	10.50
2006	3.00	2016	11.00
2007	3.75	2017	11.50
2008	4.90	2018	12.00
2009	5.25	2019	12.50
2010	6.00	2020	13.00
2011	7.00		

Source: Vlaams Energieagentschap.

Target enforcement and compliance flexibility arrangements
Incompliant suppliers have to pay an administrative penalty of 125 €/MWh, which is channelled into a public fund which is used for funding of sustainable energy activities.

TRECs issued in a certain calendar year can be used for target compliance regarding deliveries not more than two calendar years later. Hence, suppose certain TRECs are issued for qualifying generation in January 2010. These TRECs can be surrendered by a supplier for cancellation on reconciliation date, 31 March 2013, at the latest, i.e. for compliance purposes with regard to his electricity deliveries in year 2012.

Compliance performance
We only could trace compliance rates over the period 2002-2005. This rate amounted to 37%, 49%, 76% and 97% respectively in year 2002, 2003, 2004 and 2005. The poor early compliance rates appear to relate to a scarcity of certificates due to less than anticipated generation of qualifying RES-E relative to the RPS target in the first programme years.

TREC market
Since 2006 TRECs and Guarantees of Origin (GoO: used for disclosure of notably the supplier's fuel mix to consumers) can be issued and transacted together (bundled) as well as separately (unbundled). This depends on the preferences of the RES-E generators to which these 'environmental commodities' are issued. Typically the TREC represents the lion's share of the renewable feature value, whereas the Guarantee of Origin tends to have very modest, typically almost negligible, value. Figure B.1 below shows the monthly average TREC and TREC/GoO price (green and blue line respectively) for bilaterally traded certificates from January 2006 through November 2009. The monthly average TREC price (with or without GoO) fluctuated during the period shown from 104 through 114 €/MWh. Bilaterally traded TREC prices have to be reported to VREG. Furthermore, since March 2009 BELPEX runs a public TREC trading platform (www.belpexgce.be). So far the lion's share of traded certificates is traded bilaterally.

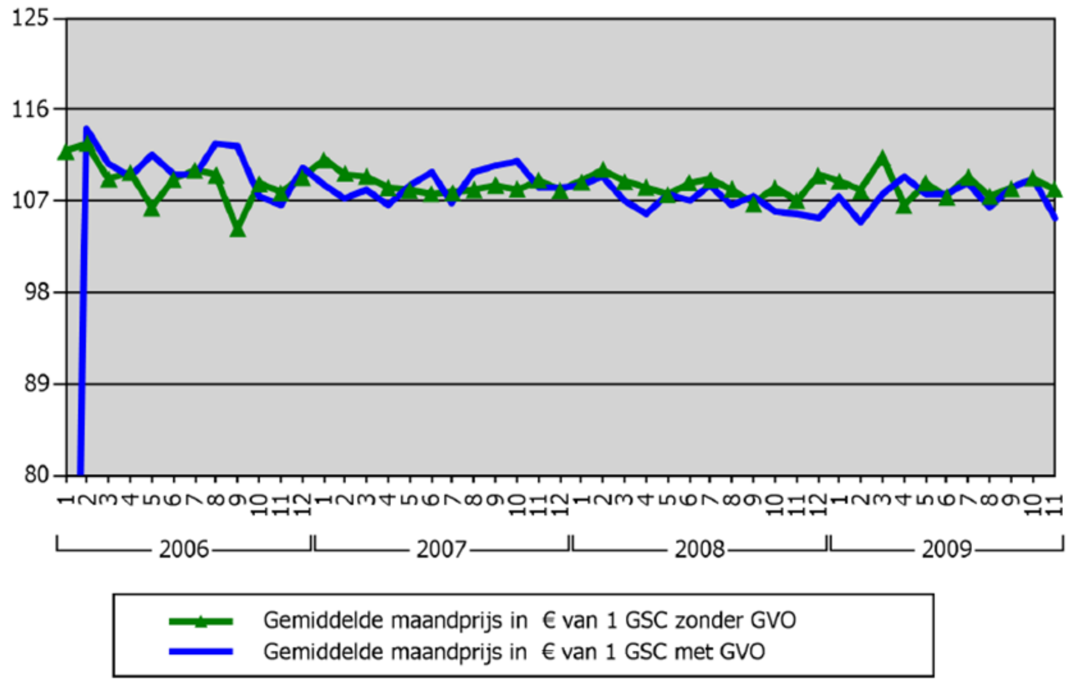

Figure B.1 *Flemish RPS: monthly average price of bilaterally traded TRECs, unbundled (green) and bundled with Guarantees of Origin (blue); 2006- November 2009*
Source: VREG.

The Belgium electricity market is quite concentrated. The retail market for delivery to households is dominated by one player, GDF Suez (Electrabel) boasting a market share of 65% in 2009, with 20% for the second largest player, SPE/Luminus. It appears that the TREC market is somewhat less concentrated. To date, 35 actors including traders have registered themselves with VREG on the supply side of the TREC market. Nonetheless, market power appears to be a serious issue for the latter market as well (Verbruggen, 2009).

Costs for obligated end-users
It is difficult to determine exactly the cost of the Flemish RPS for obligated end-users. This holds even without making allowance for additional RES-E support by the federal government, including to offshore wind generators. Let us consider year 2010 with a target of 6% and assume an average TREC price of 105 €/certificate and assume that under-compliance is negligible. Certain low-volume categories of RES-E generators are entitled to minimum TREC prices exceeding the latter amount. If this would raise the overall average transfer to RES-E generators to 110 €/certificate, the following cost per unit of final demand would be passed on by Flemish suppliers: 6% of 110 € per 1000 kWh = 0.0066 €/kWh. This amount does not yet include the 21% value added tax to which also trade in TRECs is liable. Furthermore, Flemish consumers have to contribute to the cost of RES-E support by the federal government of Belgium.

Concluding observations
It appears that support to Flemish RES-E generators by way of the Flemish RPS tends to work out to be rather profitable to the latter on average, considering their technology-specific additional cost. Some factors contributing to the apparent moderate cost-effectiveness of the Flemish support system might be:

- The small size of the TREC market with high market concentration, at least on the demand side.
- The way technology-specific additional cost differences are accounted for seems to be rather blunt, which may result in certain windfall profits.
- For the more expensive technologies the system with guaranteed TREC prices appears to mimic a feed-in premium system; this seems a reasonable system feature but for the absence of an ex post indexation mechanism regarding the power price evolution.

B.2 Italy[37]

Introduction
The Italian RPS has been in place since January 1st, 2001. To our knowledge Italy is the only country with a supply-side RPS: it imposes an obligation upon electricity generators and importers to feed a set minimum proportion of RES-E into the Italian power system. This obligation (renewable portfolio standard) can be complied with by submission for cancellation a sufficient number of TRECs to meet the standard. The TRECs, called *Certificati Verdi (CV)* are awarded to producers of renewable electricity. It covers all renewable electricity generation that came online as of April 1st 1999, for grid production or own consumption. The Green Certificates system currently in force in Italy was originally defined by the 2008 Financial Law (Legge Finanziaria 24 Dicembre 2007, n. 244) and subsequently (end 2008) more precisely defined by the a decree of the Ministry of Economic Development (Decreto Incentivi Rinnovabili 18 Dicembre 2008). Some of its main features are:

- Each green certificate corresponds to 1 MWh (Was 50 MWh previously).
- The quantity of green certificates granted to renewable power producers with installations larger than 1MW is derived from the multiplication of the real power production expressed in MWh and a coefficient, varying with the technology considered. As per ultimo 2008, this coefficient varies from the minimum unitary coefficient for the wind onshore energy to a maximum value of 1.8 for wave and tide energy, biomass and biogas energy. In this way, the

[37] Section B.2 has been prepared by Tjasa Bole.

Italian government has introduced 'banding' into its certificate system in a somewhat similar fashion to the UK certificate support scheme. Previously, one certificate per MWh was issued to the qualifying generator for all qualifying sources.
- Small plants (under 200kW wind and under 1 MW other renewables except solar) can decide to sell energy and take the green certificates or a feed-in tariff (electricity price + incentive).
- The entitlement period of qualified renewable generators to green certificates have different validity lengths depending on date of issue and for some cases fuel source:
  - 15 years for facilities that started operating after 31st December 2007,
  - 12 years for facilities that started operating before 31st December 2007 and
  - 8 years for cogeneration facilities attached to district heating facilities and non-biodegradable-waste-fuelled plants, with the possibility of a further 4 year extension.

TRECs are issued by the Gestore dei Servizi Elettrici (GSE), the Italian power services administrator, who acts as a supervisor and regulates the market by purchasing excess certificates or selling additional certificates (Art. 14 Decreto Rinnovabili). Producers and importers of electricity from conventional sources may fulfill their renewables obligation by directly injecting the RES-E corresponding to their obligation into the grid or by purchasing an equivalent number of Green Certificates. The certificates are then surrendered to GSE for cancellation in order to comply with the mandatory RPS target.

Italy also planned to offer incentives for investment in renewable energy production[38]. Nevertheless, the Budget Law 2008 explicitly forbids cumulating any kind of capital incentives and TRECs, meaning that if a new plant (produced by 2008) acceded to any kind of capital incentives, it is automatically excluded from TREC support scheme[39].Important modifications to the system have been announced by law no. 99/09 (the so-called ‘development law’ of July 2009), which is changing the definition of the parties obliged to purchase the green certificates and the treatment of co-generation. As of 2011, the obligation to acquire green certificates is transferred from power producers and importers, to the consumers. The new obligated parties will thus include:
- The Acquirente Unico, a daughter company of the GSE, whose task is to purchase power on the market and give it to distributors and retailers,
- larger industrial consumers, who do not purchase power on the market, and
- other market buyers (Poletti, 2009)

Qualifying sources and concession period
Electricity from the following energy sources entitles its producers to TREC certificates:
- Wind power
- Wave and tide power
- Hydro power (other then wave and tidal)
- Geothermal energy
- The following forms of biomass:
  - Biodegradable waste
  - Biomass and biogas via agricultural farming and forestry activities
  - Biomass and biogas of previous point used in high yield CHP reusing the heat power produced in agricultural sector
  - Gas from landfill and gas from wastewater purification processings and biogas from activities not included in the previous point

38 Eligible electricity production units include grid connected photovoltaic plants from 20 kW to 50 kW, wind energy plants from 20 kW to 100 kW, solar thermal collectors from 50 m2 to 500 m2 and biomass plants from 150 kW to 1000 kW.

39 Partial exception to this is represented by plants supplied with short chain biomass, whose construction can be supported up to the 40% of the investment value. For wind energy plants, solar thermal collectors and biomass plants, the refunds to capital costs can be up to 30 % of initial costs. For investment in solar PV, the incentives can reach 60% of the plant's capital costs. In the case of photovoltaic plants, it is hoped that this incentive scheme will help to boost Italy's installed photovoltaic capacity to 3,000 MW by 2016.

The obligation does not include PV, which is subject to a separate FIT scheme. This scheme entitles qualified generators to a preferential tariff of 40-45 €ct/kWh, guaranteed for 20 years, with the price for new investors to be reduced by 2% per annum in real terms.

Coverage of electricity end-users
As a supply-side RPS puts the obligation upstream to generators and importers of electricity, in principle all end-users of electricity are indirectly affected by a passing on of the procurement cost of TREC certificates. In the limited scan we undertook, we could not identify any currently prevailing regulation of TREC-cost mark-ups, that would exempt electricity-intensive manufacturers.

Target evolution
The mandatory renewable energy target for Italian producers will increase annually by 0.75 percentage points to 2012 (instead of the former 0.35), starting from the 2007 share of 3.05%. After 2012, a new annual increase percentage will be established by the Italian government.

Target enforcement and compliance flexibility arrangements
Obliged actors must submit by 31st March each year the amount of TRECs equal to their mandatory quota of renewable electricity to the GSE, who verifies their compliance. In case of under-compliance, the electricity producer or importer is granted a period of 30 days to purchase the missing amount of certificates on the market. If the missing TRECs balance is not settled, the GSE informs the Italian Authority on electrical power and gas, who can impose sanctions on the defaulting party. However, the Ministries of Economic Development and the of the Environment reserve the right to make changes to this standard procedure based on considerations regarding the complexity of the situation of the non-complying party or the wider context of national and international renewables targets.

Banking of green certificates is allowed for a period of another two years after the date of issue. (For example, the 2007 obligation, which was verified in 2008, could have been complied with by submitting green certificates issued in 2007, 2006 or 2005.)

Compliance performance
Compliance with quota obligations through green certificates has been very high in Italy as can be seen from Table B.3.

Table B.3 *Italian RPS compliance rate: 2001 - 2007*

Year	Qualifying RES-E volume [TWh]	Related number of TRECs	Number of TRECs utilized for compliance	Compliance rate [%]
2001	3.2	3,232,400	3,232,400	100
2002	3.6	3,593,700	3,550,200	99
2003	4.0	4,037,000	3,927,300	97
2004	4.6	4,554,223	4,435,573	97
2005	6.0	5,959,037	5,809,137	97
2006	5.8	5,797,800	5,794,950	100
2007	7.1	7,096,662	7,070,238	100

Source: GSE, 2009.

In 2007 (the latest available year), the calculated renewable electricity quota was just over 7 GWh, corresponding to 7 million green certificates. Again, under-compliance was negligible (26.464 certificates short of the cumulative obligation) (GSE, 2009).

TREC market
The TREC certificates are credited on an account of at the electronic TREC tracking system. These can be freely traded: either on the regulated TREC market, managed by GME (Gestore Mercati Energetici, a daughter company of the GSE) or bilaterally. Since January 2009 all bilateral transactions must be also reported to the 'Green Certificates Bilateral Registration Platform (PBCV)'.

Due to the design of the TREC price formation mechanism, until 2007 TREC prices mostly corresponded to a reference price (i.e. ceiling price) set by GSE, referred to as the CIP6 mechanism. This way, prices have reached a peak of 139.1 €/MWh in January 2007. After this, the change of the supply/demand conditions in the Italian TREC market made prices more connected to a standard competitive market condition, with the values of TGC falling down to 80 €/MWh in 2008 summer auction sessions.

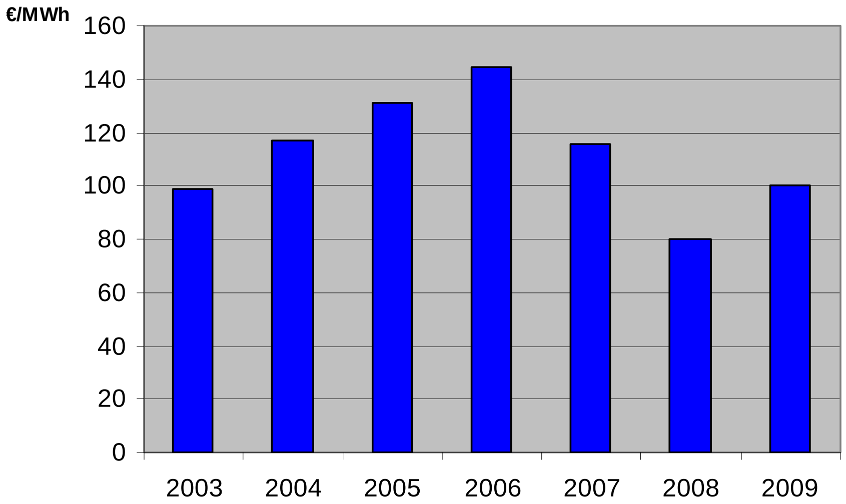

Figure B.2 *Italian RPS: yearly average price of TRECs (incl. VAT); 2003-2009*
Source: GME, 2010.

In general, the Italian green certificates market has been a long market, issuances of TRECs exceeding the RPS target. Hence, the banked certificates hanging over the market gradually increased. In 2007, when the demand amounted to 5,8 million certificates, the GSE issued 7,9 million certificates. As a result, after a peak in early 2007 prices dropped (GSE, 2008a and 2009). The implementation decree of Budget Law 2008 provided a mechanism through which unsold TGC in the market can be retired by the GSE at the mean price of the previous 3 years. Such a provision was included in order to break the collapse of TREC price and restore investor confidence. Because of this provision, prices started climbing again in 2009 and are presently stable around 100 €/certificate.

Costs for obligated parties
If the target in 2010 is 3.05 + 3*0.75 = 5.30% and the certificate cost is 100 €/MWh then producers have extra cost per MWh produced of € 5.30 (0.00530 €/kWh). This appears to include the value added tax (VAT), that is due over certificate transactions.

In the current system, the cost of acquiring the CV are increasing the overall cost of power production and are transferred to the consumers through an increase in the wholesale price. As of 2011 however, the wholesale electricity price should not anymore reflect the costs related to the CV. These costs will then be added directly to the retail price (Poletti, 2009).

Concluding observations

The RPS system in Italy seems to have led to a steady increase in the use of renewables for electricity generation. The share of RES-E in the total electricity consumption was of about 13.9% in 2005, 16.6.% in 2006 and 15,7% in 2007. Hence, up to year 2007 Italy was gradually moving towards its indicative 25% target for 2010 as specified in Directive 2001/77/CE, but whether Italy will reach it was not sure in early 2009 (EREC, 2009).

The reforms introduced in 2008 to reduce the overhang of banked certificates put *de facto* a floor under the TREC price and reduced investor risk. On the other hand, the number of changes since the scheme replaced the previous FIT regime in 1999 has given rise to policy uncertainty among investors.

The banding arrangements introduced in 2008 sought to allow for cost differences between distinct qualifying RES-E technologies, and to reduce windfall profits. We would suspect that this method is addressing this issue to a certain extent, but in a rather crude way. We deem that a well-designed hybrid RPS/FIP scheme is much more cost effective.

Furthermore, we are not surprised that Italy's supply-side RPS scheme has not triggered emulation so far. The Italian scheme would seem to have a number of disadvantages, apart from the aforementioned windfall profits issue. For example, given the fragmented MS support schemes to date TRECs issued on 'renewable electricity' imports would seem highly susceptible to double counting of the renewable feature in Italy and the country of origin. Moreover, because of the upstream nature of a supply-side RPS it seems to be more difficult to exempt electricity-intensive manufacturing companies from the burden of additional cost on the electricity bill. As stated above, it has been announced quite recently that Italy will change to a demand-side RPS scheme. The details are currently under negotiation.

B.3 Sweden[40]

Introduction
The Swedish RPS, called 'the electricity certificate system', requires all electricity suppliers and certain electricity users to purchase TREC certificates equivalent to a pre-set target proportion of their respective electricity demand - the so-called quota obligation - set for each calendar year of the Swedish RPS scheme. The scheme became operational as per 1 May 2003 and is scheduled by law to last until the end of year 2030. Its main purposes are to help increase the production of renewable electricity and reduce emissions of greenhouse gases.

Svenska Kraftnät operates the electronic platform for the Swedish TREC certificates system, the so-called Cesar accounting system. The Swedish Energy Agency acts as supervisory agency of the RPS system and is responsible for the compliance enforcement regime and overseeing the functioning of the TREC electronic platform and the TREC market.

Qualifying sources and concession period
Electricity from the following energy sources entitles its producers to TREC certificates:

- Wind power
- Solar power
- Wave power
- Geothermal energy
- Certain biofuels, as defined by regulation
- Peat, when burnt in CHP plants
- Certain hydro power sources, mainly excluding existing hydro with a capacity exceeding 1.5 MW

[40] This description of the Swedish RPS draws heavily on (Swedish Energy Agency, 2008).

To kick-start the market existing RES-E plants using qualifying sources obtained entitlement to TRECs until their phase-out in year 2012 for some and year 2014 for others. Qualifying RES-E from biomass dominates existing plants. 'New' plants, i.e. the ones that have started operations or will do so after April 2003, are entitled to TRECs for qualifying RES-E until 15 years after commissioning date or 31 December 2030, whichever date comes first. Hence, 15 years is the maximum concession period to benefit from the RPS scheme.

In 2007 13.3 TWh of qualifying RES-E and peat was produced. Biofuel plants (mostly existing ones upon start of the RPS scheme) contributed 68.2%, hydropower plants 16.6%, onshore wind power 10.8% and 4.4% was from CHP plants burning peat. By new plants 1.642 TWh was produced among which 696 GWh based on biofuels, 665 GWh by wind power and 276 GWh by (certain) hydropower plants. Qualifying solar power was still virtually negligible in year 2007.

Coverage of electricity end-users

Obligated companies having quota obligations are electricity suppliers (on behalf of their customers), electricity intensive manufacturing companies and electricity users to the extent that they have used electricity that they have produced themselves, imported or purchased on the Nordic power exchange. To date, certain electricity-intensive companies can apply for at least 50% up to 100% exemption for reasons of exposure to international competition. Their electricity use in manufacturing processes should amount at least to 40 MWh per million SEK (98k €) of the company's total sales value. The latter criterion is under consideration for revision. Also the use of ancillary power for electricity generation is exempted to meet the evolving Swedish RPS standard, as well as power demand by the TSO for its power demand to meet system losses. In 2007 a total of 96.0 TWh of electricity demand was liable to the quota obligation, as against 42.2 of TWh of quota-exempted electricity demand.

Target evolution

The scheme seeks to increase the production from qualifying sources by 17 TWh in year 2016. To date, the corresponding target after year 2016 is in the process to be determined. To achieve an expansion by 17 TWh in year 2016 compared to the 6.5 TWh level in year 2003, each year the quota obligation has been determined. This was done in such a way as to make it increasingly ambitious, based on 'a reasonable estimate' of a likely increase of production of qualifying electricity as well as the demand by obligated actors. In 2007 6.76 TWh of incremental qualifying power was produced with respect to year 2003, whereas the forecast upon start of the scheme for year 2007 amounted to 8.96 TWh. Adverse weather contingencies and delays in realisation of planned projects are stated as major explanatory factors. Given the current pipeline of projects, the Swedish Energy Agency is confident that the goal of 17 TWh of incremental qualifying electricity in year 2016 will be achieved.

Target enforcement and compliance flexibility arrangements

Obligated actors have to declare on 1 April each year the amount of electricity they sold (suppliers) or used (directly obligated end-users) to the Swedish Energy Agency. Based on this declaration and the level of the RPS standard (in %) the number of certificates for needed compliance is calculated. If the number of certificates an obligated party has cancelled falls short of the number needed for compliance over the past calendar year, a quota obligation penalty fee is due for each certificate in under-compliance. The fee is set at a level of 150% of the volume weighted average certificate price during the period from 1 April of the past calendar year until 31 March in the current year. In the first two running years of the Swedish RPS scheme a ceiling was set to the quota obligation charge (penalty fee) to protect the electricity consumers, i.e. SEK 175 / certicifate in 2003 and SEK 240 / certificate in 2004. The penalty fee for under-compliance in year 2007 amounted to SEK 318 / MWh against SEK 175 / MWh in year 2003.[41] The latter amount was equal to the penalty ceiling, applicable in the first operating year.

[41] The exchange rate is approx. SEK 10.2 = € 1. The Swedish Kronor is slightly depreciated against the Euro over the last few years.

Banking of certificates not used for compliance of the previous calendar year is allowed. Form the start a fairly large aggregated surplus has developed peaking in

Compliance performance.
Except for the first operating year, year 2003, when compliance performance was 77%, compliance each year until year 2007 exceeded 99%.

TREC market
Since the start of the Swedish RPS system the TREC price has gradually risen with fairly modest price volatility around the structural trend. In 2008 the average price was SEK 293.19 (≈ € 29) per certificate or about 0.029 €/kWh of RPS-supported electricity. The monthly trend in year 2008 is shown in Figure B.3. The TREC market is mainly a bilateral contracting market without a central trading platform. Stated reason for this is, that a diversity of actors on the supply and demand side have diverging trading requirements (Swedish Energy Agency, 2008). *Prima facie*, information from the CESAR accounting system of the Swedish Energy Agency suggests that the Swedish TREC market is rather liquid with two yearly peaks: the largest towards 1 April (quota obligation settlement date) and the other towards year ultimo for accounting reasons. The Swedish Energy Agency and Svensk Kraftmäkling, a private actor, publish price information.

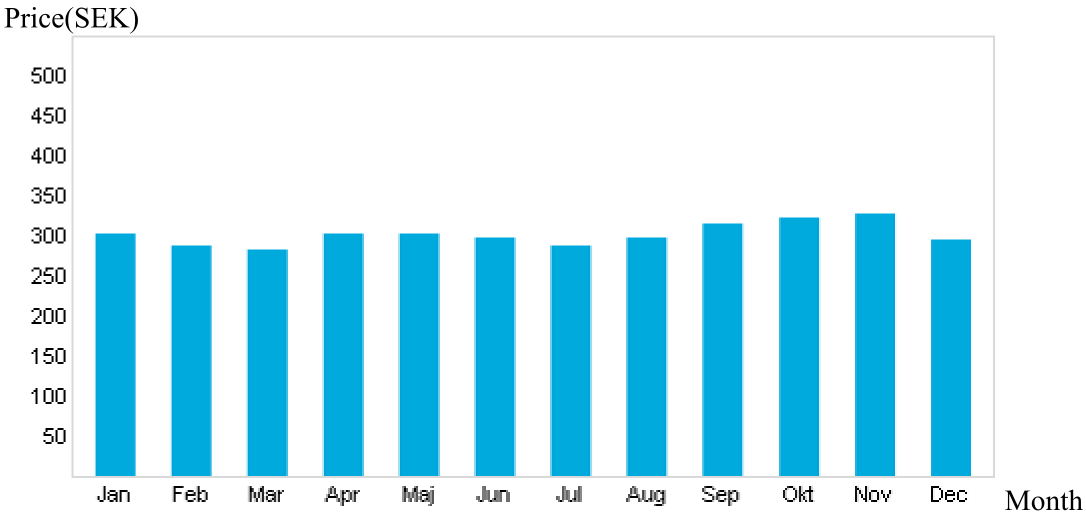

Figure B.3 *Average monthly price of Swedish tradable renewable energy certificates, 2008*
Source: Swedish Energy Agency - Cesar accounting system.

In 2007 TRECs were issued to 1149 generators. The three largest ones contributed 21% of the electricity qualifying for TRECs. We have no information on the number of parties with a quota obligation; the three largest parties accounted for 36% of the total obligation. This information tentatively suggests that no major problems of exercise of market power seem to occur.

Costs for obligated end-users
During 2007 electricity consumers paid an incremental amount of SEK 0.04 (€ 0.004) / kWh on their electricity bill for RPS-supported renewable electricity. During that year a total of SEK 1.4 billion was paid by small electricity users, primarily households (via their suppliers), and SEK 2.4 billion by ‘other users’, primarily non-exempted medium and large companies. Of the total revenues of TREC sales and quota obligation penalties (SEK 3.8 billion in 2007), SEK 800 million contributed to general revenues of the central government (value added tax) and an estimated SEK 250 million was charged by suppliers and intermediaries for transaction costs. Quota obligation penalties in year 2007 amounted to SEK 6 million. By implication, the Swedish Energy Agency estimates, that the qualifying renewable electricity producers received SEK

2.8 billion of RPS-based financial support in 2007, i.e. 73.4% of the gross annual RPS system turnover that year.

Final observations
The system has relatively simple design, which - depending on its performance - is an attractive feature. Indeed, except for some teething problems at its inception, the Swedish RPS appears to function well by and large. System compliance is almost 100%, costs are quite reasonable, windfall profits moderate. To date, the volume of additional RES-E achieved is still somewhat behind the long-term planning. The Swedish Energy Agency is fairly optimistic that the 2016 target of 17 TWh additional RES-E will be achieved. The near future will learn as to whether this optimism is vindicated. We conclude that the Swedish RPS sets a valuable benchmark for Member States which consider introducing an RPS.

Country-specific factors play a major role in the design of a well-functioning RPS. The apparent absence of large windfall profits in the Swedish case seems to relate to the apparently large potential for new low/medium additional cost RES-E projects from onshore wind, biomass, and small hydro resources. Most other EU Member States, among which notably the Netherlands, appear to have a much steeper supply curve for qualifying additional RES-E. To the extent that this is true indeed, the latter countries can only successfully introduce a well-functioning RPS in combination with prudent supplementary support. Moreover, if Sweden wishes to stimulate technical learning for promising high-additional-cost technology such as offshore wind, PV, and tidal wave, also Sweden cannot circumvent the issue of additional support on top of its RPS system.

B.4 UK[42]

The U.K. RPS, the so-called Renewables Obligation (RO), is the main support scheme for renewable electricity projects. It places an obligation on UK suppliers of electricity to present an increasing number of ROCs per 100 MWh sold to their customers (target) for successive RO accounting years running from 1 April of a certain RO operating year through 31 March the next year. Target compliance can be proven by obligated actors through purchase and subsequent cancelling of the required number of TRECs, called Renewables Obligation Certificates (ROCs) in the U.K. A penalty fee, called the buy-out price, is due for each MWh in under-compliance. In principle, one ROC is issued and passed on to a licensed qualifying RES-E generator for each MWh of qualifying renewable electricity generated. The Renewables Obligation[43] and the Renewables Obligation (Scotland) came into effect in April 2002, the Northern Ireland Renewables Obligation in April 2005. Hereafter we zoom in on the Renewables Obligation only, noting that the RPS of Scotland and Northern Ireland run similarly to the RO.

Up to operating year 2009/2010 a generic RPS prevailed, rewarding RES-E generation from all qualifying sources with one ROC per MWh. Up to this year the RO target was expressed as a proportion (%) of electricity sold by a supplier in an accounting year to be qualifying renewable electricity. With effect of accounting year 2009/2010 an RPS with technology banding was created with 5 yearly reviews of banding and ‘emergency reviews’ if needed. But for the last two description topics, for want of more recent data the description below relates almost completely to the situation up to year 2007/2008.

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[42] Most of the information in this description of the U.K. RPS is taken from the website of OFGEM, the U.K. regulatory agency for U.K. gas and electricity markets. See: http://www.ofgem.gov.uk/Sustainability/Environment/RenewablObl/Pages/RenewablObl.aspx and from the wensite of the Department of energy & Climate Change (DECC): http://bis.ecgroup.net/Publications/EnergyClimateChangeDECC/NewRenewablegeneral.aspx At the time of writing, medio January 2010, the GBP-Euro exchange rate was £ 1 = € 1.12. The British Pound has gradually receded against the Euro over the last few years.

[43] Covering England and Wales.

On the outset it should be stated that general renewables deployment conditions in the UK are less favourable than in most EU Member States with lengthy and complex permitting and, to a lesser extent, grid connection procedures for project developers. Especially the deployment of onshore wind in the UK is negatively affected by these circumstances with powerful NIMBY opposition. This is the case in spite of the large low-additional-cost potential as the UK is endowed with abundant wind resources. So far the UK government has achieved modest progress in lowering the permitting and connection hurdles. The effectiveness of any support system is unfavourable affected by these framework conditions. As the government has much more control of these issues regarding offshore wind, the government sets its stakes to a large extent on the latter option.

Qualifying sources and concession period
RES-E from following sources are qualifying, subject to meeting regulatory requirements, qualifies for the issuance of ROCs to the operators of the generating plants concerned: Biomass from anaerobic digestion; biomass including the bio-degradable part of waste and biomass from biomass co-firing; landfill gas; small-scale hydro power; onshore and offshore wind; marine power (tidal; wave power).

Coverage of electricity end-users
We have not identified exempted electricity users in the documents consulted so far, but do not exclude that exemptions are defined in prevailing legislation.

Target evolution
The initial target proportion was set at 3% of a supplier's sales volume in base year 2002/2003, rising in incremental steps to 10.4% in year 2010/2011 rising subsequently by 1% up to 15.4% in year 2015/2016. We note in legislation introduced per 1 April 2009 the target is defined in a terms in a certain number of ROCs: i.e. 9.7 ROCs per 100 MWh in year 2009/2010, increasing in subsequent years.

Target enforcement and compliance flexibility arrangements
The penalty rate (buy-out payment) was set initially at £30/MWh in base year 2002/2003, rising in step with the Retail Prices Index. The buy-out price in 2008/2009 was £35.76/MWh and, to date (2009/2010), stands at £37.19/MWh. The buy-out payments are channelled into the buy-out fund. The proceeds of the buy-out fund are paid back after closure of the accounting year to suppliers in proportion to how many ROCs they have presented.

If an obligated actor fails to pay the buy-out price for non-compliance because of, for example, insolvency, all obligated actors that were in compliance are required to make a second additional payment in proportion to their obligation to make up for the shortfall up to the mutualisation ceiling, standing at £224mn in year 2009/2010.

TREC market
As so far the suppliers have been notably in under-compliance, consequentially the ROC price has exceeded the buy-out price. High ROC prices are attractive for holders of qualifying RES-E assets. At the same time, this would suggest substantial windfall profits for low-additional-cost RES-E operators (e.g. the ones using relatively cheap biomass technologies and onshore wind-power) at least up to year 2008/9, before technology banding was introduced. ROC price volatility would appear to have been moderate.

To our knowledge, virtually all RES-E assets are owned or controlled - through purchasing power agreements with small independent operators - by the six large integrated suppliers in the Great-Britain market. These six integrated suppliers also cover the lion's share of electricity delivered to end-users. Independent RES-E generators are not well organised in the U.K., compared to some other EU Member States such as Denmark and the Netherlands.

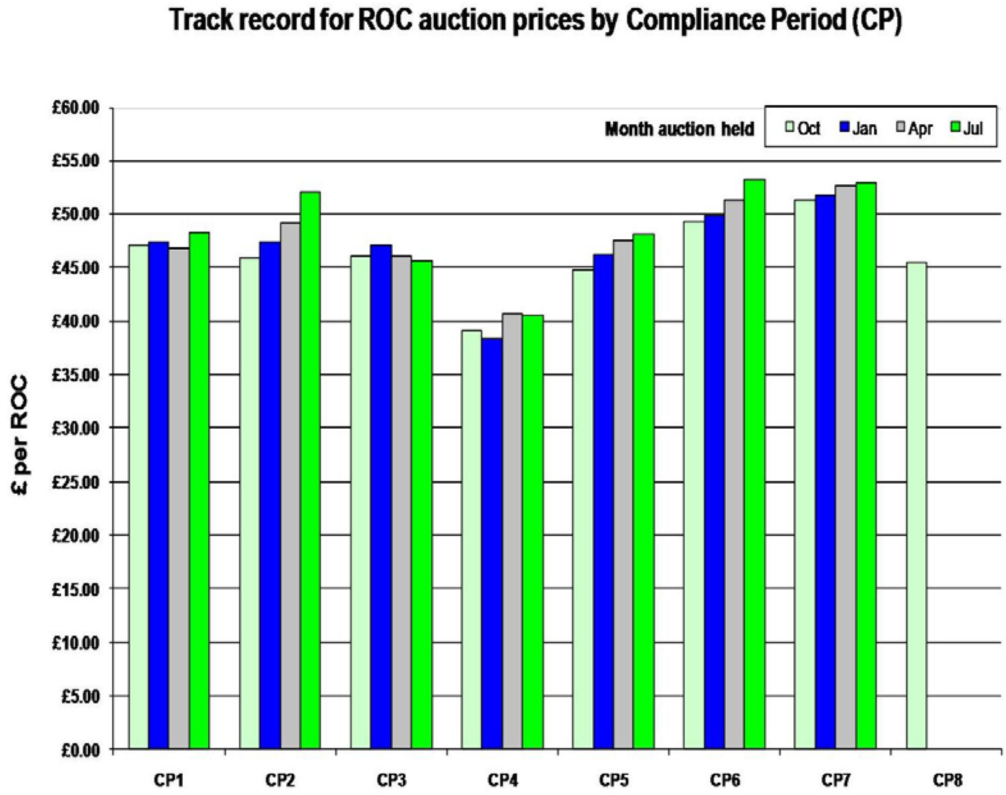

Figure B.4 *ROC clearing prices from a quarterly private electronic trading platform, 2002-Q4 through 2009-Q4*

Source: http://www.e-roc.co.uk/graph.cfm.

Costs for obligated end-users

The cost to end-users served by obligated suppliers are capped by the buy-out price. For example, with a target of 9.7 ROCs per 100 MWh in 2009/2010 and a buy-out price that year of 37.19 £/MWh, the additional cost of the RO scheme for the consumers boil down to £0.0036 (€0.0040) / kWh. The latter amount is to increase in a quite predictable way along with the tightening of the target and the indexed buy-out price.

A major design consideration for the RO system has been to keep the additional costs of RO-support to renewable electricity predictable and affordable to the consumers.

Main features of the new technology banding system

New secondary legislation has come into effect on 1 April 2009. This new legislation includes the Renewables Obligation Order 2009. Its most salient features are the following:

- The level of the compliance obligation for 2009/2010 is set at 9.7 ROCs per MWh. In the subsequent administrative (compliance) years the value of this level is set by DECC prior to the start of each obligation period, based on a series of formulas in the revised legislation.
- From April 2010 onwards the value of the ROC is ‘banded’ dependent on the generation technology type. Five (temporarily six) bands are proposed ranging from 0.25 to 2.0 ROCs per MWh generated (see Table B.4). The bands are based on the cost gap the distinct technologies have to bridge to reach commercial maturity.

Table B.4 *Technology bands in RO regulations to date, intended to be fixed up to year 2013*

Technology category	ROCs/MWh	ROC value per MWh at ROC price of 45 £/MWh
Landfill gas	0.25	£11.25
Sewage gas Co-firing of biomass	0.50	£22.50
Onshore wind Hydro Co-firing of energy crops Co-firing of biomass with CHP Geo pressure Standard gasification & pyrolysis	1.00	£45.00
Offshore wind Biomass, n.e.s. Co-firing of energy crops with CHP	1.50 [1)]	£67.50 [1)]
Wave and tidal stream, barrage and lagoon(≤1 GW) Advanced gasification & pyrolysis Anaerobic digestion Energy crops with or without CHP Solar PV Geothermal	2.00	£90.00

1) Subject to review by DECC, offshore wind projects which sign contracts between 23 April 2009 and 31 March 2010 confirming that the project will go ahead and start offshore works before the end of 2011 will qualify for 2 ROCs/MWh. Projects which sign contracts between 1 April 2010 and 31 March 2011 and start offshore works before the end of 2012 qualify for 1.75 ROCs/MWh.

Source: DECC, ENVIROS.

- Two mechanisms are introduced set out to reduce risks to investors that the ROC price will steeply fall in the event that the RO target is exceeded. The *headroom mechanism* will adjust the level of the target upwards up to a level of 20% of electricity sold by suppliers. The *ski-slope* mechanism intents to moderate sharp price reaction in the event of a certain level of oversupply. The RPI-based indexation of the buy-out price will be discontinued after 2015. This may imply that the real value of a ROC will gradually decline after 2015.
- For PV-generators and (other) micro-generators using qualified renewable sources a feed-in tariff has been introduced. With effect of the new regulations, the coverage of the RO has thus been slightly reduced.

Concluding observations

At least before the new reforms the Renewables Obligation did not quite function as anticipated. The environmental effectiveness was fair and cost effectiveness quite low. Promising but high-additional-cost technology was poorly served by the original RO support system. At least before the new reforms, the system led to large windfall profits to low-additional-cost RES-E generators. This was brought about by the absence of technology specific support features, and further compounded by the recycling mechanism applied to the proceeds of the buy-out fund.

The recycling mechanism rewards RES-E generators for sluggish implementation of new RES-E capacity, as collective target under-compliance jacks up the ROC price. Hence, also considering the far from perfect market conditions the recycling mechanism would seem to induce a perverse incentive towards collective under-compliance. With high ROC prices, the generating branch of an integrated supplier tends to earn high windfall profits, whilst the supplier branch adds the additional RO cost on the bill.

Recent reforms might have moderated the pre-existing disadvantages to the RO system to some extent. For example, micro generators are less exposed to the asymmetric negotiation power with integrated suppliers: the support benefits can be kept out of the contract when negotiating a

PPA. Also by way of banding, technology-specific cost features are taken into consideration to date.

With the new reforms the RO support system has become extremely complex. It deals better with technology-specific RES-E costs, but still in a rather crude way. Any misalignment between the number of ROCs per MWh for a certain technology and the additional cost of electricity produced by that technology are amplified by the uncertain extent of collective under-compliance and the consequential uncertainty in the ROC price evolution.

In the recent reforms of the RO the recycling mechanism has been retained. This and the extreme complexity of the RO to date and the preservation of the recycling mechanism of penalty payment proceeds render the RO support mechanism unsuitable for emulation by other Member States.

In principle, the UK can strongly gain from harmonisation of support schemes. Yet to move towards a position capable of doing so, shelving the buy-out price payments recycling mechanism would seem indispensable. Moreover, introduction of an intelligent feed-in premium system would be helpful to better address technology cost divergences in lieu of technology banding. Moreover, these suggested reforms would provide more cash flow certainty to investors and less room for excess profits that still exist in the current UK support system. The upshot would be a higher environmental and cost effectiveness of the UK support scheme.

Appendix C Glossary of abbreviations and acronyms

CCGT	combined cycle gas turbine technology
CCS	carbon capture and storage
DECC	(U.K.) Department of Energy and Climate Change
EEG	Erneurbare Energien Gesetz; German FIT law
FIT	feed-in tariff (support system)
FIP	feed-in premium (support system)
GHG	greenhouse gases
MS	Member State(s)
NREAP	National Renewable Energy Action Plan
OFGEM	Office of the Gas and Electricity Markets: the U.K. regulatory agency
PPA	purchasing power agreement
RES	renewable energy sources
RES-E	electricity from renewable energy sources
RO	renewables obligation (support system), also often referred to as renewable portfolio standard
RPS	renewable portfolio standard: support system, also called renewables obligation or quota-based system; often system compliance is administered by tradable renewable energy certificates
SDE	Dutch support system for renewable energy (electricity and gas) of the FIP support systems category
TWh	TeraWatthour = 10^{12} Wh = 10^{9} kWh = 10^{6} MWh = 10^{3} GWh
TREC	tradable renewable energy certificate
TSO	transmission system operator