Analysis of the flexible support mechanisms in the Directive on the promotion of the use of energy from renewable sources

The Nordic Working Group for Renewable Energy

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Content

Foreword

This study was commissioned by the Nordic Working Group for Renewable Energy in March 2009.

The report is based on a literature review, interviews of selected companies and organisations and market expertise and analysis of the GreenStream Network Ltd. The report does not present the opinions of the Working Group for Renewable Energy. All the conclusions presented in the report are those of the authors (see below).

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1. Introduction

The Nordic countries have a long history in co-operation and a common electricity market. The long-term objective of Nordic countries is to promote an efficient, competitive, secure and sustainable energy supply. The EU countries have set a binding target to increase the share of renewable energy to 20% by 2020. The European Parliament approved a legislative resolution on December 17th 2008 on the proposal for a Directive on the promotion of the use of energy from renewable source ("the Directive"). This Directive become part of the European Community legislation in 2009. The Directive sets national targets for renewable energy, but it also provides various flexibility mechanisms that enable co-operation between countries in reaching the national targets. It is however still not clear how these flexible mechanisms should be used, nor the consequences on the electricity market and renewable energy sources.

The objective of this project is to evaluate the usefulness and consequences of utilising the Flexible Mechanisms described in the Articles 6-11 ("Flex-Mex") of the Directive in Nordic Countries. Moreover, the objective is to provide basis for conclusions and political recommendations on whether and how to cooperate and move forward in this area. In addition to basic principles of the flexible mechanisms, the project concentrates on analysing the arrangements needed between the Nordic Countries to utilise the flexible mechanisms and analysis of benefits and problems of using Mechanisms.

The report is divided five sections. Chapter 2 introduced the RES directive and Flexible Mechanisms. In chapter 3, lesson learnt from other markets are used as starting point in drawing possible frameworks for Nordic countries. Chapter 4 summarizes presents outcome of various co-operation scenarios and their benefits. In Chapter 5 some selected topics are discussed from RES Flex-Mex point of view. Chapter 6 provides conclusions and recommendations.

2. The Renewable Energy Directive

The European Parliament adopted a legislative resolution on the proposal for a Directive on the promotion of the use of energy from renewable sources ("the Directive") on December 2008. The proposal for the Directive was approved by the Council in the beginning April 2009 and the new Directive 2009/28/EC was published in the Official Journal of the European Union on June 5th 2009. The Directive sets a binding target to the community to increase the share of energy from renewable sources[1] (RES) up to 20% and the share of energy from renewable sources in all forms of transport to at least 10% by 2020. The share of renewable energy is measure from the *gross final energy consumption* which again is defined in the Directive as follows:

"The energy commodities delivered for energy purposes to industry, transport, households, services including public services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission".

The preamble 15 of the Directive recognizes that as each EU Member State has different a starting point and potential to increase the share of RES, the 20% target is further translated into individual national targets[2] listed in the Directive Annex I. The 10% transport sector target is however common for all countries.

2.1 The Directive requirements from a Nordic perspective

Table 1 summarises the targets for the Nordic countries. The Directive does not define a target for Norway and Iceland, but as EEA members, an assumption is made that both countries implement the Directive into their national legislation and also take a national target to increase the share of RES. We have estimated a comparable target for both Norway[3] and for Iceland[4].

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[1] According to the Directive Article 2 energy from renewable, non-fossil sources is wind solar, geothermal, aero thermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.

[2] The sharing the required total increase in the use of energy from renewable sources between Member States on the basis of an equal increase in each Member State's share weighted by their GDP, modulated to reflect their starting points, and by accounting in terms of gross final consumption of energy, with account being taken of Member States' past efforts with regard to the use of energy from renewable sources.

[3] The target for Norway is assumed to be the same that was utilized in the study *Opportunities for harmonisation of instruments for the promotion of renewable energy in the Nordic countries*, prepared by GreenStream Network Plc for the Nordic Council of Ministers in 2008.

Table 1. RES increase targets for the Nordic countries.

	Denmark	Finland	Iceland*	Norway*	Sweden
Level in 2005	17.0%	28.5%	72.9%	59.0%	39.8%
Target for 2020	30.0%	38.0%	80.0%	66.0%	49.0%
Required increase	13.0%	9.5%	7.1%	7.0%	9.2%

**Estimate*

Box 1. Norway and the RES Directive

Status of Norway and the EU Renewable Energy Directive

Norway has still not started the negotiations with the EU on the renewable energy directive. This was recently confirmed by the Norwegian Minister of Oil and Energy.

The ministry has begun the discussions with the EU Commission but the meetings have so far only had the aim to find a common understanding of the content of the renewable energy directive and how it should be handled in the relation to Norway as a non-EU Member State.

The ministry also stated recently that they want to be on track with the EU Member States on this issue, which implies that this issue is high on their agenda at the moment. It was not said whether Norway will be able to submit their preliminary NREAP until December 31 this year, but the minister said they will put high pressure on this issue during the winter. However, Norway plans to submit their final NREAP during next spring in line with the EU Member States. The Minister also characterized the conversations with the EU Commission as constructive and positive.

When taking the calculation methodology of the EU Directive into account different calculations shows that Norway will get a renewable energy target around 62%.

The Member States are required to set targets for the shares of energy from renewable sources in transport, electricity and heating and cooling. Reaching renewable energy targets should be closely linked with energy efficiency measures. Moreover, the Directive also points out that boosting technology development requires also notable financing from the Member States. The importance of promoting technological development and innovation as well as providing opportunities for employment and regional development, especially in rural and isolated areas, is emphasised in the Directive.

Taking into consideration the global competitive position of the EU countries is an important issue and the cost-efficiency of the measures is a vital element when

[4] For Iceland the increase target is created based on the Iceland's goal to increase the share of RES to 100% by 2050. A linear development from the current situation towards the target is assumed. Reference for base year 2005 value: Eurostat, (2010).

designing the strategy and tools for reaching the national and EU-level targets. The Member States are encouraged to pursue all appropriate forms of co-operation and thus the Directive recognises and encourages the following actions:

- Co-operation can take place at all levels, bilaterally or multilaterally
- Target calculation and target compliance
- Statistical transfers between Member States
- Joint renewable energy projects with Member States or third countries[5]
- Joint support schemes
- Exchange of information and best practices

In order to reach the 2020 target, Member States must create and follow ***an indicative trajectory line*** that sets limits where the annual RES production can vary. If a country fails to remain within the trajectory line for two years the Directive defines actions that the country must take in order to return to the path and further ensure that the overall target is reached.

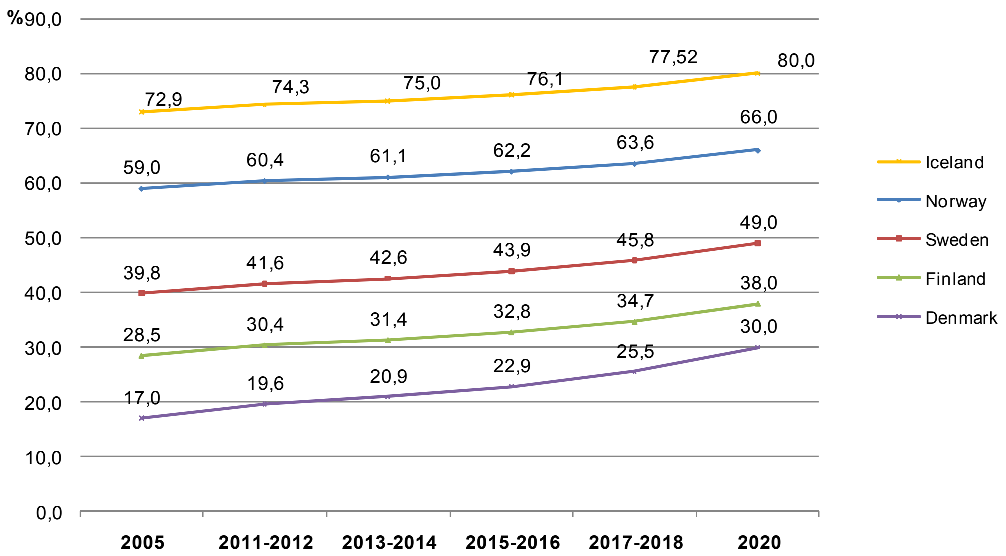


Figure 1. Indicative trajectory lines for the Nordic countries.

Figure 1 illustrates the indicative trajectory lines the Nordic countries must follow during the obligation period. The targets are based on figures presented in Table 1, thus for non-EU countries Norway and Iceland the increase lines are at this point more indicative than the ones presented for the EU member countries. First is the baseline year 2005 and the last is the target year 2020, other shares are calculated as an average of the

[5] Third countries refer to countries that are not members of the European Community.

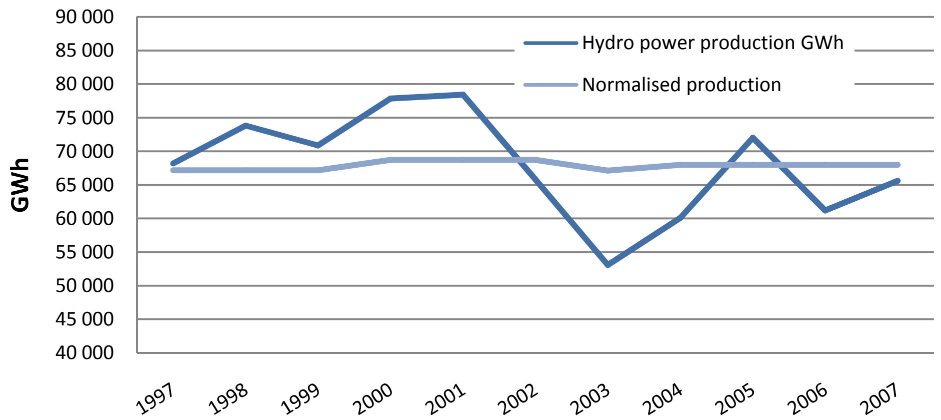
two-year period. The calculation method for the trajectory line is in Annex 1B of the Directive.

The Directive requires the use of a specific ***normalization rule for hydropower and wind power*** that balances the yearly differences in the production. The rule is important for countries such as Sweden and Norway who strongly rely in hydro power. Due the rule, they do not have to report on the yearly production changes that can momentarily drop them from the trajectory line but also, they are not able to benefit from the peaks through the flexible mechanisms that are presented later in this Chapter. The calculation formula for the normalization rule is in the Directive Annex 2. The impact of the normalisation rule on actual production is presented in a case study in Box 2.

Box 2. The normalization rule

Case Swedish hydro power production 1997-2007

The graph below illustrates how the normalization rule impacts on the calculated amount of hydro power production compared to actual production.



2.2 Administrative arrangements and reporting

The Member States must ensure that any national rules concerning the authorisation, certification and licensing procedures that are applied to any activity related to the production of electricity, heating or cooling from renewable sources are *proportionate and necessary*. In addition, the Article 13 of the Directive specifies also other administrative tasks related to local and regional administration, building sector and public buildings and on the use of harmonised standards and labels, all which the Member States must consider.

In addition, the Member States must provide necessary information, including public, for all relevant parties and ensure that sufficient awareness-raising, guidance and training is implemented.

The Directive Article 4 requires the Member States to submit ***a National Renewable Energy Action Plan (NREAP)*** to the European Commission by June 30th 2010. In the NREAP the Member States must specify the *national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020, taking into account the effects of other policy measures relating to energy efficiency on final consumption of energy, and adequate measures to be taken to achieve those national overall targets, including co-operation between local, regional and national authorities, planned statistical transfers or joint projects, national policies to develop existing biomass resources and mobilise new biomass resources for different uses, and the measures to be taken to fulfil the requirements of Articles 13 to 19*[6].

By June 30th 2009 the Commission will publish a template for the national action plans. In addition, the Member States are required to release a forecast for the use of the flexibility measures by the end of year 2009. A more specific time line for the required reporting is showed in Figure 2 and the reporting requirements regarding the flexible mechanisms are summarised in Box 2.

In the NREAPs the Member States should also present their expected gross final energy consumption between 2010 and 2020. This includes energy of all types (both from renewable and conventional sources); the total amount and specified for each sector. Member States should use the definitions, calculation rules and terminology laid down in the Directive and in the Regulation (EC) No. 1099/2008 (on energy statistics), while preparing the NREAPs.

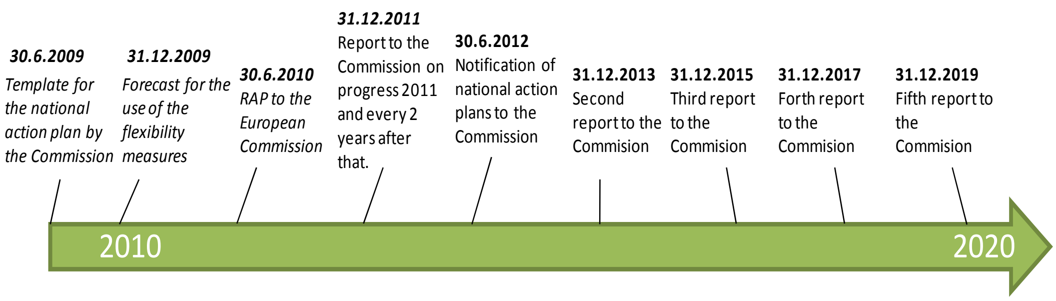


Figure 2. Reporting timeline within the RES Directive.

[6] The Article 13 states the rules for administrative procedures, regulations and codes. The Article 19 again defines how the greenhouse gas impact of bio fuels and bio liquids are calculated.

The Member States are obligated to report to the Commission on the progress in the promotion and use of energy from renewable sources by 31st December 2011 and every 2 years after that. The reporting schedule, especially the one defining the reporting requirements for the first NREAPs is tight and can prove to be challenging for the Member States.

The Commission has established ***an online public Transparency Platform*** to increase transparency and to facilitate and promote co-operation between the Member states. Thus as the Member States provide first their indicative reports and later the NREAPs, the Commission publishes all documents on a specific website[7].

The Member States are expected to have an outlook on their possibilities and interest to utilise the mechanisms and be able to answer on rather specific questions about their intentions. The Box 3 in the previous page lists the reporting requirements for the flexible mechanisms as provided in the NREAP template.

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7 http://ec.europa.eu/energy/renewables/transparency_platform_en.htm

Box 3. Reporting requirements for the flexible mechanisms.

- **Procedural aspects**
  a) Describe the national procedures (step by step) established or to be established, for arranging a statistical transfer or joint project (including responsible bodies, contact points).
  b) Describe the means by which private entities can propose and take part in joint projects with either Member States or third countries.
  c) Give the criteria for determining when statistical transfers or joint projects shall be used.
  d) What is going to be the mechanism to involve other interested Member States in a joint project?
  e) Are you willing to participate in joint projects in other Member States? How much installed capacity / electricity or heat produced per year are you planning to support? How do you plan to provide support schemes for such projects?
- **The estimated excess production of renewable energy compared to the indicative trajectory which could be transferred to other Member States**
- **The estimated potential for joint projects**
  a) In which sectors can you offer renewable energy use development in your territory for the purpose of joint projects?
  b) Has the technology to be developed been specified? How much installed capacity / electricity or heat produced per year?
  c) How will sites for joint projects be identified? (For example, can local and regional authorities or promoters recommend emplacement? Or any project might participate independently from its location?)
  d) Are you aware of potential for joint projects in other Member States or in third countries? *(In which sector? How much capacity? What is the planned support? For which technologies?)*
  e) Do you have any preference to support certain technologies? If so, which?

2.3 The Flexible mechanisms

The Directive (Articles 6-11) includes the following flexible mechanisms; ***statistical transfers between Member States, joint projects between Member States, joint projects between Members States and third countries, and joint support mechanisms.*** As said, the Directive encourages exchanging information and best practices and other voluntary coordination between all types of support schemes.

2.3.1 Statistical transfer (Article 6)

Within statistical transfer the Member States may agree and may make arrangements for the statistical transfer of specified amount on energy from renewable sources from one Member Sate to another. The transfer should not affect the achievement of the national target of the Member State making the transfer meaning that the country delivering must first ensure that it is on track fulfilling its own commitment. The transferred amount must be deducted from the amount of energy from renewable sources that is used for the compliance of the country making the transfer. Furthermore, it can be added to the amount that is taken into account when measuring the compliance of the country accepting the transfer. The Directive requires that the Commission is notified on the transfers by all Member States included in the transfer process.

Figure 3 illustrates the structure of statistical transfer as defined by the Directive.

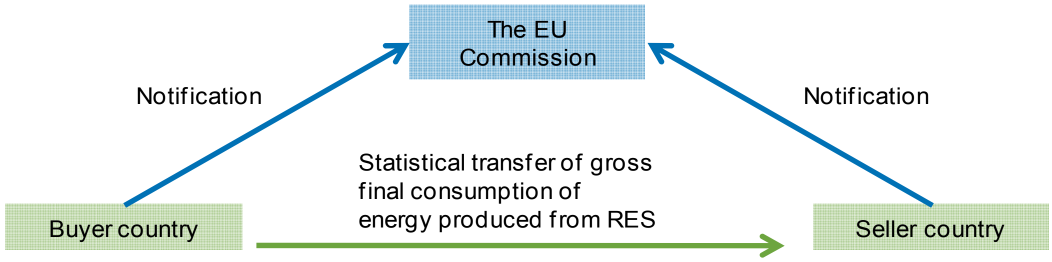

Figure 3. The structure of statistical transfer between Member States.

The transfer can be agreed for one or several years but important is that the Commission must be notified on the amount and price of transfer latest three months after the end of the year in which the transfer takes effect. The transfer becomes effective only after all countries have provided their notifications to the Commission.

2.3.2 Joint projects (Article 7)

The concept of joint projects means that two or more Member States may cooperate on all types of joint projects relating to *the production of renewable electricity, heating and cooling* meaning that one country having more favourable conditions to increase renewable energy production will host the project and the other country or countries will also benefit from the production. This co-operation may also involve private operators.

In order that the RES electricity, heating or cooling produced within a joint project can be counted in the target of another Member State the project - whether it means the establishment of a new installation or the refurbishment of an existing installation – must have become operational after 25 June 2009 as stated in the Directive. The host country must notify the Commission on the amount of renewable energy that will be counted towards the national target of the other country. This is likely to require yearly reporting between the participating countries and the Commission. Figure 4 illustrates a framework structure of joint projects within the EU. The blue arrow is for communication that is required in the Directive and green arrows illustrate other possible interaction needed between the countries.

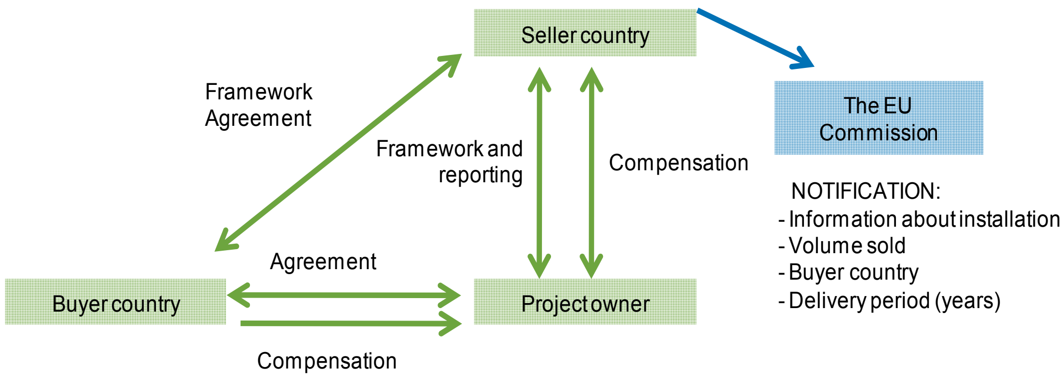

Figure 4. Framework for joint project between Member States.

2.3.3 Joint projects with third countries (Article 9)

The Directive also enables one or more Member State to cooperate with one or more third country in all types of joint projects regarding *the generation of electricity* from renewable sources. A prerequisite to the acceptability of the project is that the electricity produced within the project must be consumed in the Community area which a gain requires that the following conditions are met:

- *an equivalent amount of electricity to the electricity accounted for the buyer country has been allocated to interconnection capacity by all responsible Transmission System Operators in the country of origin, the country of destination and, if relevant, each third country involved in the transit;*

- *An equivalent amount of electricity to the electricity accounted for the buyer country has been registered in the schedule of balance by the responsible Transmission System Operator on the Community side of an interconnector.*

Furthermore, the third country cannot provide support for the RES production, other than investment aid. As in the case of Community internal joint projects, the establishment of the new installation or the refurbishment of an existing installation where the electricity is produced, must have become operational only after 25 June 2009 in order the RES electricity can be counted towards the national overall target of an EU Member State. Figure 5 illustrates a sketch for a framework structure of joint projects with third countries. Again the blue arrows are for reporting that is required in the Directive and green ones for other possible interactions needed.

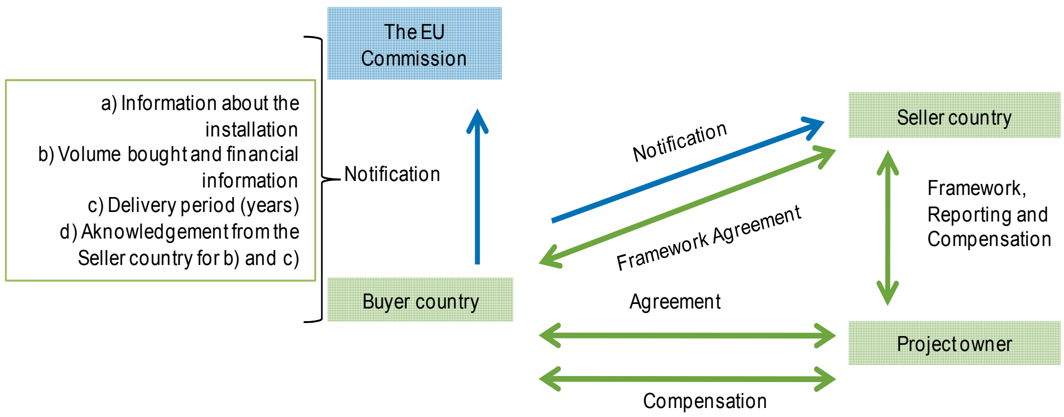

Figure 5. Framework for joint projects between Member States and third countries.

2.3.4 Joint support schemes (Article 11)

Two or more Member States can decide to jointly or partly co-ordinate their national support schemes for RES production. In such case, a certain amount of energy from renewable sources produced in the territory of one participating Member State can be counted towards the target of another participating country. This requires a statistical transfer of a specified amount of RES production between the participating countries or alternatively, they must set up a specific distribution rule that allocates the produced RES between the participating Member States.

Figure 6 illustrates a co-operation framework for joint support scheme. If the countries choose to utilise statistical transfer the structure must be further modified to fit with the reporting requirements set for the mechanism.

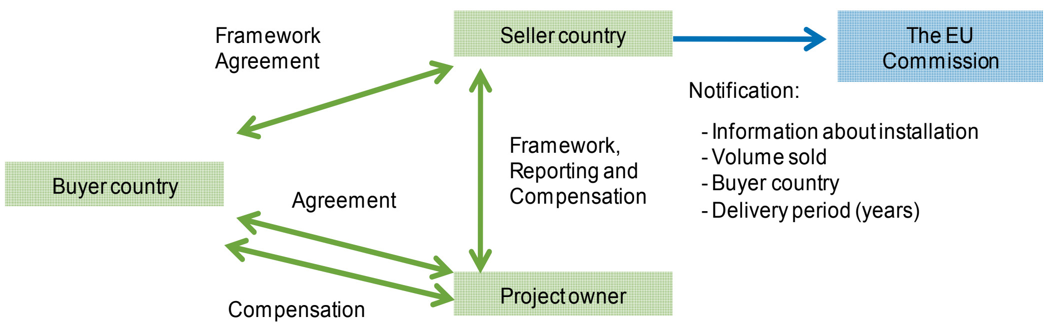

Figure 6. Framework for joint support scheme between Member States.

3. Contractual arrangements for the RES Flex-Mex

The application of the ***RES Flex-Mex***[8] will require that co-operation structures, contractual frameworks and mutual understanding are reached within all parties that are involved in the co-operation. Especially the implementation of joint projects will affiliate also private entities to the co-operation which must be considered differently than when co-operation is purely between states. The RES Flex-Mex are new mechanisms and consequently there is very little experience how they operate. However, co-operation structures in general, especially between the Nordic countries do exist and consequently do offer ground for Nordic co-operation. In climate policy the emergence of global markets and the utilisation of flexible mechanisms in reaching the emission reduction targets provide valuable experience and lesson learnt that can be applied to RES Flex-Mex.

In this Chapter the contractual applications from the CO2-policy are first viewed. The analysis is followed with the identification of the specific characters of the Nordic countries and in section 3.3, Alternative frameworks for Nordic co-operation, the opportunities for contractual arrangements for the utilisation of the RES Flex-Mex in the Nordic context are considered.

3.1 Lessons learnt from the carbon markets

The international carbon regime that has created global markets during the past decade has many structural similarities to the EU level RES regime: the regimes are both based on national level targets which countries strive to reach by implementing policies. In the climate regime the policy tools are partly internationally agreed whereas in the RES policies implemented the emphasis has been in national policies. However the Flex-Mex is a clear step towards increased international flexibility at least in the EU level. Most importantly, a fundamental basis for the international climate regime is the flexible mechanisms that allow countries to reduce emissions and/or purchase emission reductions in countries where it is considered cheaper. In following, the RES Flex-Mex is compared to the carbon mechanisms with a focus in the administrative and contractual arrangements.

Box 4 briefly summarises the background and main elements of the international climate regime and the flexible mechanisms within it.

[8] This onwards RES Flex-Mex refers to the four flexible mechanism defined in the Directive.

Box 4. The international climate regime.

The Kyoto Protocol and the flexible mechanisms

The United Nations Framework Convention on Climate Change (**UNFCCC**) was adopted in 1992 as the basis for a global framework for climate agreement. The objective of the Convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system.

The Convention was later complemented by **the Kyoto Protocol.** Under this treaty the industrialised countries have committed to reduce their emissions by an average of 5 percent by 2012 against 1990 levels. Industrialized countries must first and foremost take domestic action against climate change. The emission targets for industrialized countries are expressed as levels of allowed emissions, or "**assigned amounts**", over the 2008-2012 commitment period.

The countries must first and foremost take domestic action against climate change, but the Protocol allows them a certain degree of flexibility in meeting their emission reduction commitments through three specific market-based mechanisms. The three **Kyoto mechanisms** are:

- International Emissions Trading (**IET**)
- Clean Development Mechanism (**CDM**)
- Joint Implementation (**JI**)

The carbon market spawned by these mechanisms is a key tool in reducing emissions worldwide. JI and CDM are the two **project-based mechanisms** which feed the carbon market. JI enables industrialized countries to carry out projects with other developed countries (usually countries with economies in transition), while the CDM involves investment in projects that reduce emissions in developing countries.

The project-based mechanisms generate tradable emission credits (CERs and ERUs) that the countries can surrender for compliance. Within the IET industrialised countries can trade with their assigned amount units, AAUs. The mechanisms are administered by specific bodies established under the UNFCCC. The CDM mechanism that involves developing countries is more strictly regulated whereas the IET and JI, which involve only countries that have an emission reduction target, are increasingly regulated by the countries involved.

We assess that Joint Implementation (JI) offer an illustration and example how the procedure of the RES Flex-Mex joint projects could be carried through and what kind of documents and negotiations are required. Moreover, International Emissions Trading (IET) is considered to have similarities with statistical transfer. Below the lessons learnt from the carbon mechanisms are evaluated and similarities of the carbon mechanisms with the renewable flexible mechanisms are discussed.

3.1.1 Joint Implementation (JI)

JI allows a country with an emission reduction or limitation commitment under the Kyoto Protocol (industrialised countries) to earn emission reduction units from an emission reduction or emission removal project in another industrialised country. The emission reductions can further be counted towards meeting the buyer's emission target as illustrated in Figure 7. The principle of JI is to offer a flexible and cost-efficient tool for countries to fulfil their Kyoto commitments, while the project host country benefits from foreign investment and technology transfer.

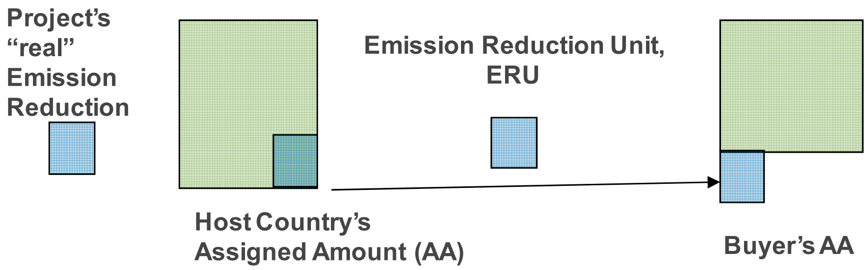

Figure 7. Framework for Joint Implementation

JI projects are typically implemented in the former Soviet Union countries including the eastern parts of the EU as there are relatively cheaper opportunities to reduce emissions. The current JI project pipeline is dominated with energy efficiency, RES and industrial efficiency projects thus similar projects than what the joint Flex-Mex projects could be. Renewable energy projects account 29% of the number of the projects and 8% of the expected emission reduction volume. On the host country side, Russia and Ukraine account 74% of the expected emission reduction volume.

Table 2. Comparison of joint Flex-Mex projects and Joint Implementation

Element	Joint Implementation, Track 1	Joint Implementation, Track 2	Joint RES Projects
Basis	Project	Project	Project
Product	Emission Reduction Units (ERU, tCO2e) that are based on the production	Emission Reduction Units (ERU, tCO2) that are based on the production	MWh renewable energy
Host Country approval	Yes	Yes	Yes
Buyer Country approval	Yes	Yes	Yes
Reporting	According to national guidelines	Monitoring report to Accredited Independent Entity, Determination letter, Approval letter and Verification letters to Joint Implementation Supervisory Committee etc.	According to national guidelines, notification to the EU Commission

The implementation procedure of a JI project must follow a specific pattern called Track. At the moment there are two Tracks. If the country hosting the project is considered to fulfil certain eligibility requirements[9] a simplified *Track 1* may be applied. In that case, the

[9] The eligibility requirements relate to certain, mainly monitoring and reporting requirements that the countries must meet. The requirements are listed in: http://ji.unfccc.int/Eligibility/index.html.

host country is responsible in monitoring the projects and the emission reductions created. In order to facilitate JI projects in countries that are not fulfilling the eligibility requirements, a Track 2 procedure was established. In Track 2 a specific Joint Implementation Supervisory Committee (JISC) supervises the procedures as the host country is not able to do it by itself. Dividing countries to two tracks has promoted the development of JI projects especially in such countries that do not have the ability to manage the JI projects fully by themselves[10]. It has enabled an earlier project implementation in Track 2 countries but the UN led supervisory procedure ensures that the quality requirements for the projects and emissions credits are met. Currently the number of projects is 240 from which 27% are Track 1 projects. In total, the projects are expected to generate 350 million Emission Reduction Units (ERUs) by 2012.

Figure 8 illustrates the procedure what is required when a Track 2 JI project is established. Although the process is from many parts defined by the UNFCCC it still requires the establishment of necessary authorities in both the host and in the investor country. The project participants again are private entities. A detailed explanation of the procedure is provided in Annex 1. Joint Implementation Cycle Documents.

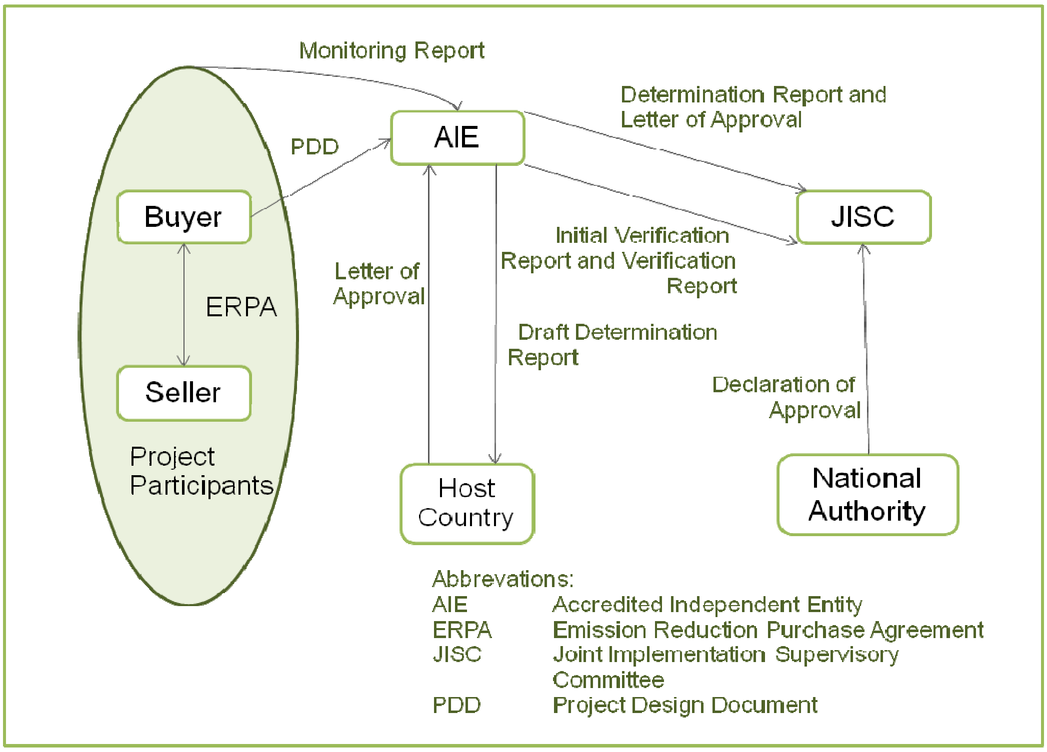

Figure 8. Joint Implementation negotiation procedure in Track 2.

[10] Many Track 2 projects may change to Track 1 as soon as the host country becomes eligible for Track 1. This enables earlier start for projects that do not have to wait for Track 1 eligibility.

Figure 9 illustrates the various key steps that are required in developing a JI project form a project developer's perspective. Typically the development of a JI project takes at least a year and developing the 'carbon component' – the received emission reductions and the underlying project go in hand in hand. It is also worth noticing that the price of carbon credits generated in the project depends strongly on the risks related to the project. Projects in later stages of implementation can typically sell their carbon credits with higher prices as many of the project and carbon component related risks have reduced from the project idea stage. Again projects that agree on the sale very upfront, have a higher risk profile that impacts the pricing as well. The pricing and the time of contracting is valid point for the joint Flex-Mex projects as well which will be discussed more in section 3.3 Alternative frameworks for Nordic co-operation.

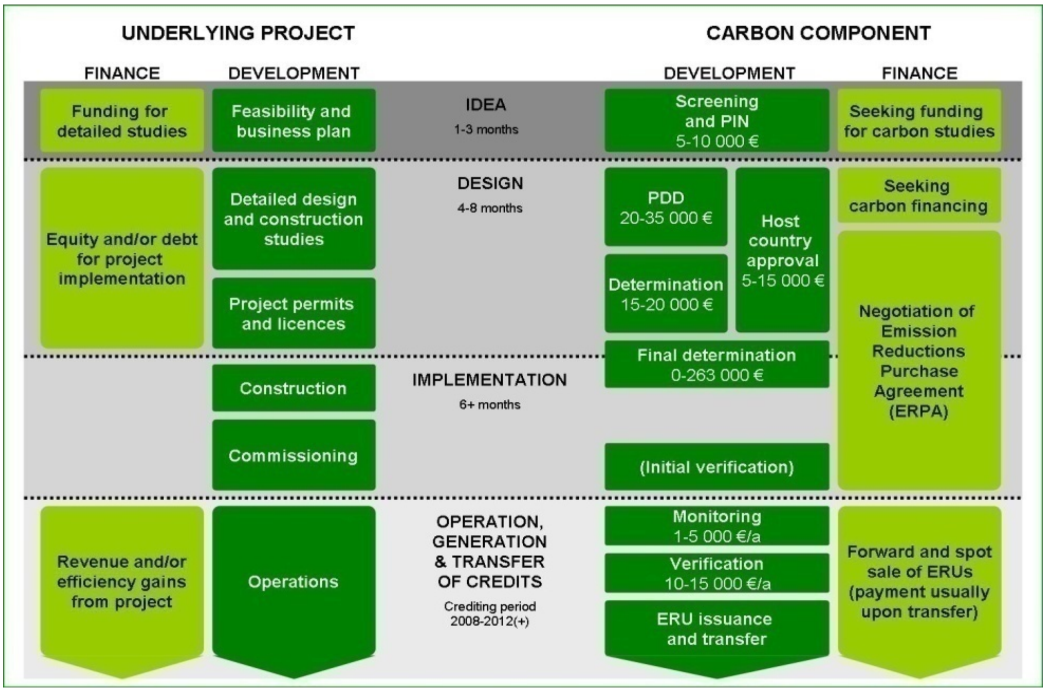

Figure 9. Key steps of developing a JI project.

Compared to the other project based mechanism, the CDM, where the projects are implemented in developing countries that do not have a quantified emission reduction obligation, JI can be considered to be very modest both in number of projects and in expected emissions reductions. The potential of emission reduction projects in former Soviet Union countries and in Eastern Europe is vast but JI has so far failed to capture large number of realised projects. The main hinder has been reluctance of Russia to provide a formal approval for the JI projects. Overall a well defined and stable regulation procedure is needed to create good investment environment also in the carbon markets. Success of CDM in China has demonstrated that when a large emissions reduction potential and good investment environment are combined with clearly defined rules carbon markets can kick-off many emission reduction projects in relatively short time period.

The lessons learnt from the host country perspective are similar to CDM: countries that have established clear rules and procedures how to apply JI or CDM project status, have also managed to attract JI/CDM project financing. Compared to Russia, Ukraine that has the national procedures for project approval in place has many JI projects in advanced stage and new projects are coming into pipeline.

For JI Track 2 and for the CDM[11] a major bottleneck in the project implementation is the formal UNFCCC approval process. Especially the CDM is considered to be ‘a victim of its own success’ as the approval bodies is unable to manage all the projects in time. This highlights the importance of such body’s ability to adapt and, if needed, expand to meet the expectations of the project developers.

Lessons learnt: JI

The JI Track 2 process is a relatively complex process and we foresee that the flexible mechanisms of the RES Directive do not necessarily have to be based on such a complex framework. Moreover, at this stage it is unlikely that there will be a central supervisory entity overseeing the mechanisms (other than the EU Commission giving its formal approval) but the Member States are responsible for such measures. For this purpose Track 1 JI procedure provides a ground were one could build also national procedures for RES joint projects. The national host country procedures vary and responsibilities of managing JI depends on national circumstances.

Based on the current experience from JI, ***countries that are keen on hosting projects should establish very clear rules and guidelines for how to implement projects. Moreover, the investment environment should be stable in order to attract foreign investments***.

3.1.2 International Emission Trading (IET)

The Kyoto protocol includes a possibility for industrialized countries to trade with the Assigned Amount Units (AAUs) under the International Emissions Trading (IET). IET is a so called cap-and-trade scheme where a capped amount of emission units is first allocated to the entities included in the scheme. After the compliance period entities have to surrender an amount of units equaling their emissions during the period. Participants[12] can sell and buy the units depending on whether it is cheaper to reduce emissions or to buy credits. This in principle directs the emission reduction projects to least-cost alternatives.

According to Kyoto rules countries can participate in IET if they fulfill certain eligibility requirements which are mainly related to accounting, monitoring and reporting requirements. Figure 10 demonstrates how the IET operate under the Kyoto framework.

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[11] Like JI Track 2 also the CDM is monitored and guided by specific UN led bodies created to serve the CDM.

[12] Countries may allow companies or private entities to trade with AAUs on their behalf. The EU emissions trading scheme is in 2008-2012 period based on idea that certain amount of the Member State’s AAUs are allocated to the companies included in the EU ETS.

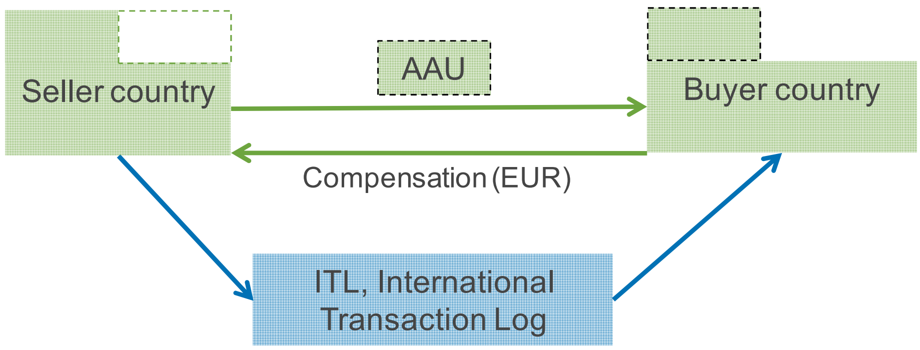


Figure 10. International Emissions Trading under the Kyoto Protocol

The main difference in the principles of the IET and JI is that while in JI, the emission reduction project created additional emission reductions to the country AAU amount in IET the credit amount is limited to the predefined level. The AAU emission trades are bilateral agreements. The UNFCCC monitors the process only through tracking the transaction of the AAU-units through the International Transaction Log which is the electronic system taking care of the transactions between the countries credit balances.

Table 3. Comparison of International Emissions Trading and Statistical Transfer

Element	International Emission Trading	Statistical Transfer
Basis	CO2 allowances called Assigned Amount Units	RES production
Product	AAU (tCO2e)	RES, MWh
Parties	Industrialised countries that have ratified the Kyoto Protocol	EU Member States
Reporting	Yes, to the UNFCCC	Yes, to the EU Commission

Table 3 compares the IET and statistical transfer. A common character for them is the state level, bilateral nature of the trades. In both mechanisms an administrative body, either the UNFCCC or the Commission keeps track on the transactions. In IET the UNFCCC has a larger role in actually providing the transaction whereas in statistical transfer the Commission takes care that the price and amount traded is public information.

Lessons learnt: IET

The Kyoto protocol's first commitment period is ongoing and some Annex B countries have fulfilled the eligibility criteria to participate IET. In recent months, the number AAU transactions have increased and activity level can be expected to increase towards end of the Kyoto period 2012. Still at the moment the IET market is dominated with few large transactions with very little information about prices and contractual terms. Typically AAU transactions involve two countries (buyer and seller) which mean that negotiations etc. might proceed in a slow phase and might involve other items related to co-operation between the countries. On the other hand, some countries might organize tenders where potential buyers are competing.

The IET and Statistical Transfer have many similarities – both are based on government to government transaction and are not related to a specific project. In reaching the emission targets the IET is often seen as a, secondary balancing mechanism in case were the buyer is not able contract enough emission reductions from CDM or JI. However, some countries are likely to take very active buyer role in the IET market. (Please see Box 5 for more thorough discussion on IET.)

From the seller perspective it is advisable to inform market about the selling interest early enough so that potential buyers are aware of the possibility. At this stage, it is difficult to estimate how many countries are planning to utilize Statistical Transfer but we expect this market to be very small next years. Still, activity could increase towards 2020 when the real costs and potential of RES are known.

3.1.3 Conclusions for carbon markets

In brief, the lesson learnt from carbon regime is promising: a well defined and predictable scheme can lead to increased financing in RES projects and moreover, contribute in reaching the political target cost-efficiently. From the project host country perspective it is important to create clear rules and guidelines for implementing projects such as Joint Projects and there should be clear set of criteria which project are eligible or are allowed to sell their production abroad. The market for Statistical Transfer is expected to evolve somewhat slower phase than Joint Projects and lessons learnt from the second half (2010-2012) of the Kyoto Protocol is likely provide insights of potential dynamics of Statistical Transfer –market. At this stage, there is limited experience on the IET.

Box 5. GIS: greening the international Emission Trading

Green Investment Scheme (GIS)

International Emissions Trading does not earmark revenues from sale of AAUs to any climate related purposes and IET has been criticized that it allows former Soviet Union countries and Eastern European countries to sell their excess AAUs due to decline in their economies since 1990 (so called “hot air”) without any investment in emission reductions. In order to guarantee that the revenues from selling AAUs are used in climate related investments, some countries have implemented so called Green Investment Schemes (GIS). GIS does not operate directly under any international body – it is rather a framework under which IET transactions can be earmarked and revenues used in emission reduction projects or other projects that can be seen related to climate change policies (education, capacity building etc.). Figure 11 illustrates an example of GIS framework. As you can see, GIS is a add-on to IET. In this framework, revenues from AAU transactions are directed to GIS Fund which further distributes revenues to projects. In this scheme projects are divided in two categories:

- Hard greening projects are emission reduction projects that have easily quantifiable emission reductions similar or close to Joint Implementation projects
- Soft greening project have clear climate change related benefits but emission reduction is not easily determinate such as capacity building, communications or education.

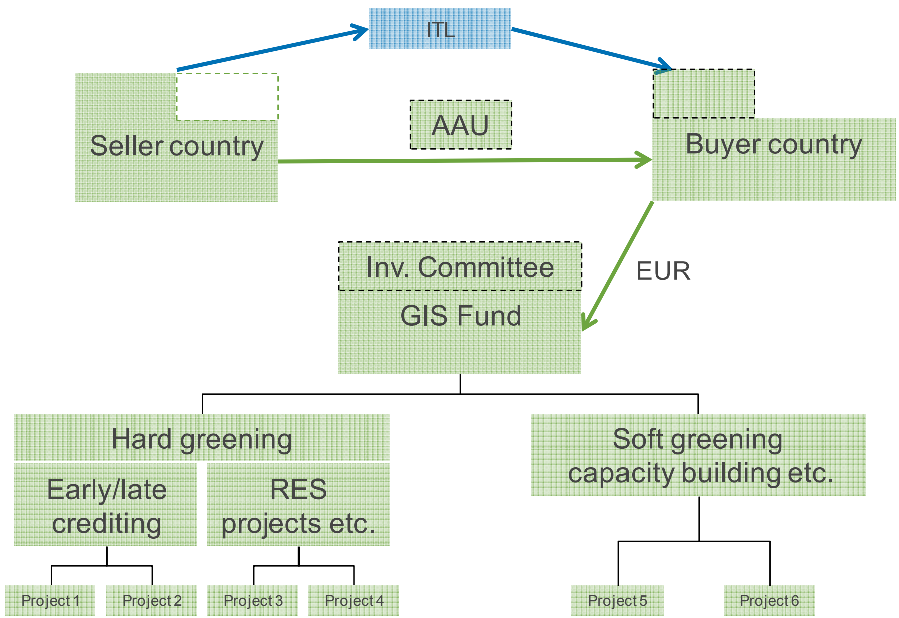


Figure 11. Example of a Green Investment Scheme.

Currently there are only few operational GIS schemes, most well known are Ukrainian and Lithuanian schemes. However, the experience from the schemes is still short and it is too early to draw conclusion from their efficiency.

The need for GIS has arisen from buyers of AAUs to guarantee that they are not simply buying “hot air” and that the revenues from the transactions are directed to climate related investments. At this stage, it is hard to see similar concerns in the Statistical Transfer or Joint Projects. The EU targets for renewable energy for all the Member States are very ambitious and all countries need to build considerably amount of new RES capacity – there is hardly any country that would already have exceeded its national target or would do it in mid-term. Consequently, all potential sellers of Statistical Transfer would have to make investments in order to be able to sell RES production in statistics.

3.2 Starting points for Nordic co-operation

Although the plans to utilise the mechanisms can be specified or even modified later, most countries are already at the moment enforcing certain type of renewable energy strategy that impacts on their interest to utilise the mechanisms. In the case of the Nordic countries some indication on their interests may be driven from their previous efforts to increase renewable energy, type of support provided to RES and most important, on their interest to co-operate in energy production related issues. The Nordic countries have so far chosen rather different approaches on increasing the share of renewable energy:

- Denmark has a long history with feed-in tariffs; the first “big wave” of RES was already seen a decade ago. Most of the low hanging fruits are already used for wind energy capacity increase. Previously support was based on a combination of energy taxes on fossil fuels, fixed feed-in tariffs, investment subsidies and research and development support. These mechanisms continue, but are at the moment supplemented with, a more market based incentives like a premium on the top of the electricity market price and an open tendering for certain RES projects
- Finland has long relied on the share of RES the forest industry has brought. After the formal requirements to increase the share of RES and overall the need to look for more diverse production palette has made Finland to launch a fixed feed-in tariff for wind and biogas as previously the support was based on investment support and taxes.
- Iceland again has a favourable baseline for RES and also unique sources. Iceland has recently approached the EU thus it is becoming more likely that the 2020 RES policy will be similar to other Member Countries. Iceland is however geographically isolated location which limits the co-operation in energy production in some level.
- Norway has also had a favourable baseline to utilise RES thus the share is already at the moment high. However Norway has indicated to take a similar 2020 target thus the share must increase from before. Until now RES support has been based on investment support but Norway recently announced that it is planning to form a joint certificate market with Sweden from 2012 onwards thus the future support will be market based.
- Sweden has already a high share of RES and somewhat favourable circumstances to further increase the share. The increase target is however ambitious as well. Sweden has chosen a market based approach to support RES and generally the system is considered to function well.

The chosen support mechanisms can give direction to countries interest to co-operate in RES production. Norway and Sweden are already joining a market thus their stand on co-operation is clearer. For other countries the decision is also impacted by national policies – as long as the targets are national also national measures will remain high on agenda in many countries. Still, from electricity market perspective the Nordic countries are already cooperating and have a joint electricity market. Following this, the starting point for co-operation is better compared to many other countries.

The following Chapters head to illustrate the opportunities Nordic countries have for co-operation, how the cooperative frameworks could be structured and finally what kind of impacts – challenges and benefits – the utilisation of the mechanisms can have.

3.3 Alternative frameworks for Nordic co-operation

Based on the framework that the Directive gives for the Flex-Mex and what kind of base line the examples from the carbon market have given this section heads to sketch and discuss on the possible structures for the Flex-Mex in Nordic context.

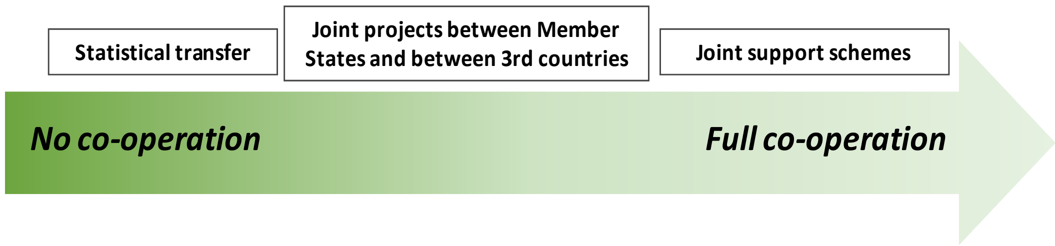


Figure 12. The level of co-operation under the Flex-Mex.

Figure 12 roughly illustrates the level of co-operation under the different mechanisms. Their location on the arrow is considered based on the required preparations, level and amount of involved parties and on how ad-hoc based or long term commitment the co-operation is.

3.3.1 A contractual scheme for statistical transfer in the Nordic Countries

Statistical transfer can be considered as the 'lightest' form of co-operation as countries can utilise it on ad-hoc basis or as a regular tool to balance their RES balances. However, as in all forms of co-operation also the statistical transfer requires that the countries involved both have an incentive to cooperate and further benefit from it in some level. A country could consider statistical transfer as a valid option in the following cases:

- An unexpected delay in national capacity increase that creates a temporary deficit to country's balance compared to the indicative trajectory line.
- Delayed national capacity increase which leads to need to cover the shortfall for certain years.
- Continuous deficit in the national balance that is more cost-efficient to cover with statistical transfers than national capacity increase.

Figure 13 illustrates what kind of arrangements statistical transfer is likely require. As the transfer is purely a statistical issue thus no physical delivery of electricity, heating or cooling is required the framework does not require the involvement of private sector.

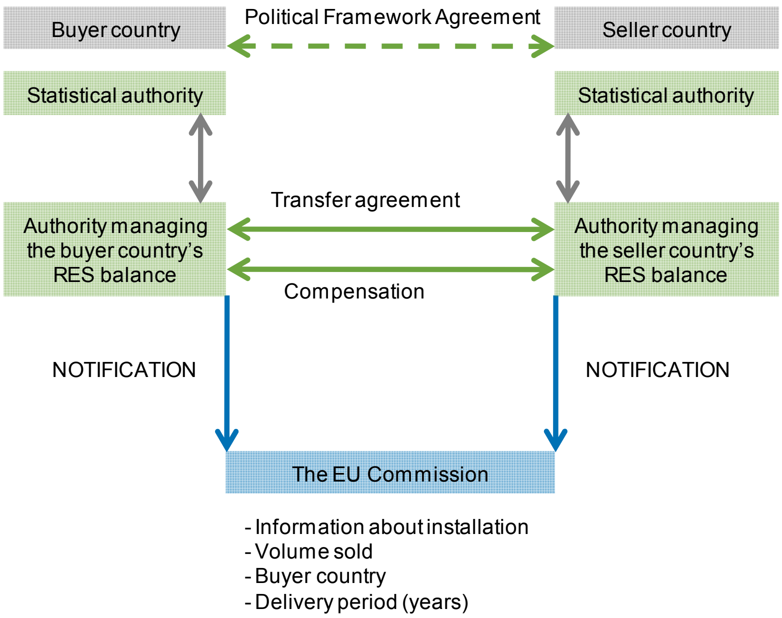


Figure 13. A contractual framework for statistical transfer.

The first step required is that the countries involved create a framework agreement for statistical transfer that overall enables the utilisation of the Flex-Mex and creates initial rules for compensation. The countries RES authorities agree on the yearly transfer; communicate with the national statistical authorities and further provide Commission the necessary notifications. In principle, statistical transfer is a simple form of co-operation but what is likely to be the most complicated part is to find the political will and consensus for its utilisation and further agree on the compensation, whether it is purely monetary based on energy prices or a part of some wider co-operation structure between the countries. In practical level the time schedule for the notification procedure can prove to be challenging as the Commission requires the information to be ready in a time that the national statistics are not maybe used to deliver it.

In the Nordic countries the joint support scheme between Sweden and Norway makes the utilisation of statistical transfer more likely as the countries need to agree how the RES production under the scheme is distributed. In addition, the use of statistical transfer (or a comparable distribution mechanism) is going to be continuous.

3.3.2 Opportunities for joint Nordic projects

As in the case of statistical transfer, the first step required also in the case of joint projects – whether enforced in the Nordic countries or outside the EU borders – is the political will to co-operate and utilise the mechanisms. In case of joint projects it is also a question of where the capacity is built and how the costs; the disadvantages and again the overall benefits occurring from the project implementation are divided between countries. These questions will be examined more closely in Chapter 0. Overall, the driving force behind the joint projects is to find more cost-efficient and innovative solutions to meet the targets than the national measures have to offer.

OPTION A for a joint project framework

Figure 14 illustrates an option for the structure of the establishment of a joint project between countries. In this option the initiative for co-operation comes from the political level that creates a co-operation framework between the Nordic countries (two or more).

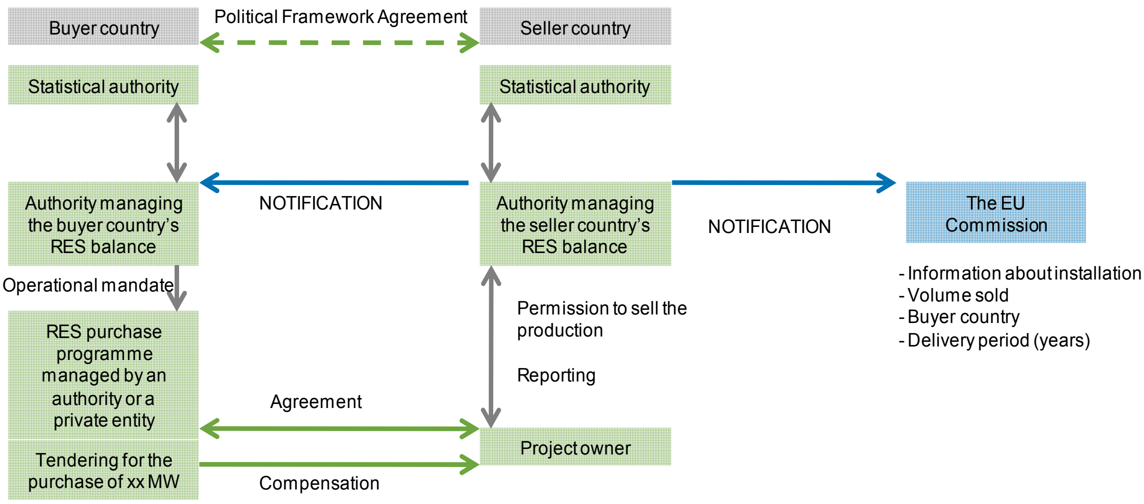


Figure 14. Option A for a joint project framework

The Option A framework is structured as follows:

- Both countries determine an authority who is responsible (together with the statistical authorities) in managing and reporting on the country's RES balance.
    - Here, carbon markets again offer an example as CDM and JI mechanisms require that each country establish a DNA (Designated National Authority) who is responsible to give the country approval to the emission reduction projects.
    - DNAs are usually part of ministries who are in general responsible to govern international climate related issues. In case of RES the body can as well be a public organisation under a ministry responsible on energy issues.
- The authority gives an operational mandate to a specific ***purchasing programme*** that is established to take care of the operational functions of the renewable energy balance. The purchase programme can be managed either by a public or a private party.
- According to the purchasing plan the programme organises a public tendering to contract certain amount of capacity or production. Private entities that are under the political framework agreement may participate to the tender and winners are paid compensation by the programme.
- The seller country's national authority managing the RES balance provides the project owner a permission to sell the rights to the capacity/production
- The seller authority also provides required notifications to the EU Commission and to the buyer country.

OPTION B for a joint project framework

The option B is close to similar to the option A but here, the seller country has taken a more proactive role to establish projects on its grounds and has created a RES selling programme. Figure 15 illustrates the structure of the framework.

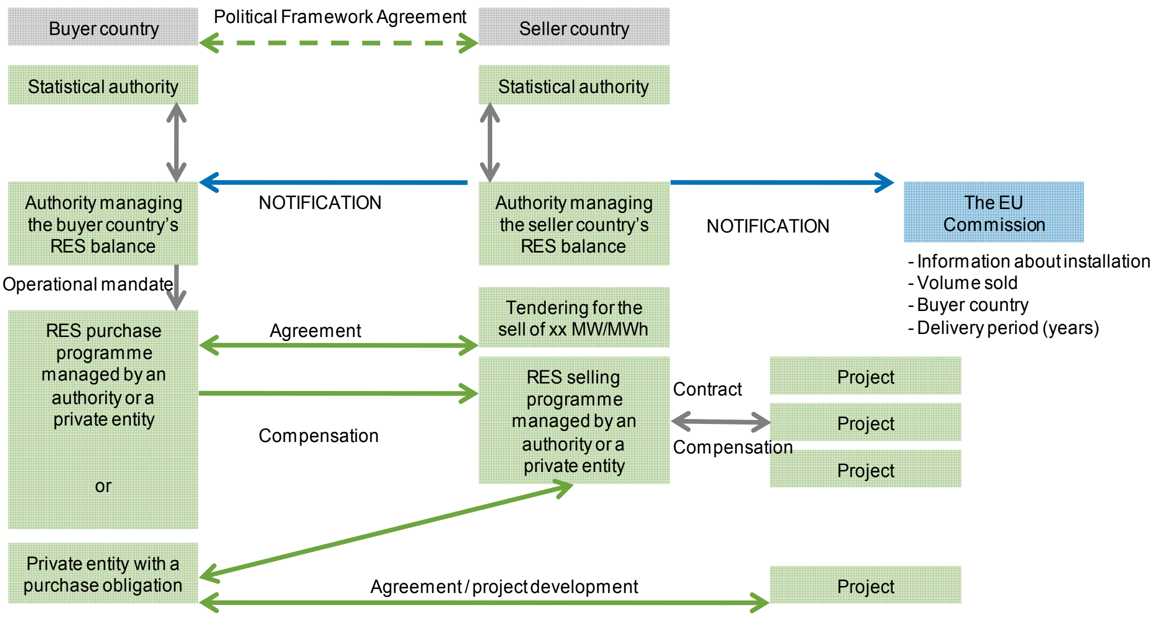


Figure 15. Option B for a joint project framework

The Option B framework is structured as follows:

- The determination of a national authority.
- The seller country's authority gives an operational mandate to a specific ***selling programme*** that is established to
  - Form a strategy for the sale of additional RES production
  - Agree on the project implementation with private sector participants who sell the green value of their production to the Selling programme.
- The selling program organises a public tenders to sell the green value of the production. Private entities or national purchasing programs that are under the political framework agreement may participate to the tender and the winners pay compensation to the selling program.
  - It is of course possible that once the framework exists private participants can in principle contract green production over the official programs.
  - In such case the national authorities or depending on the level of mandate given, the programs must still have a proactive role in managing the RES balances.
- The seller authority provides the required notifications to the EU Commission and to the buyer country.

Viewpoints for framework Options

On important issue to agree in the framework is *what the buyer agrees to buy*. In theory, the buyer country purchase programme could commit to the project in three different levels:

- investment in the equity of the project
- contract production capacity
- contract production

However states normally do not invest directly in electricity production capacity thus it will be more natural for the purchase programme to contract RES production or RES production capacity. In case production is contracted, the selling country takes the risk if the production remains lower than what was initially estimated. Again, if production capacity is contracted the buyer carries the risk on the possible changes in the production. If the buyer is a single, private actor (for example a company under a green certificate scheme is offered flexibility) it may be an attractive option to invest in the equity as well.

In both cases an important aspect to determine in the contract is *the time frame* for which the buyer is entitled to benefit the green value of the production. It is possible to adjust it for example:

- with the 2020 obligation
- project lifetime
- a specific period within the obligation period

The timeframe is partially dependent on what is agreed to be bought. The ‘lighter’ the commitment is the more flexible the timeframe can be whereas an investment in the equity is likely to result that the project is viewed from its lifetime perspective. The chosen commitment level and time frame are important determinants also when considering *the distribution of costs and benefits* that occur from the projects.

The role of the selling programme is similar to the buyer side purchasing programme; it has an operational mandate from the national authority and organises tenders to sell shares of RES capacity/production to the buyer. In addition, the selling programme is responsible for seeking and contracting suitable projects. The framework also presents an option that the operational mandate - or obligation – to purchase the RES is given either to the programme presented before or to private entities. The private entities can either utilise the possible selling programme or develop projects by themselves.

The role of the programs is dependent on how mature the possible Flex-Mex market is. In the most advanced scenario countries have strategies for selling and buying and there is a market for the green value of RES. But taking into account the time constraint and the net deficit on RES at the moment, a more likely scenario is that the utilisation of Flex-Mex projects is limited to individual cases for starters. The role of co-operation may however increase notably towards 2020. While reaching the 2020 targets the EU will agree on new long run targets and f the experiences so far are promising, the Flex-Mex market may very well have an established market after 2020. Hence, the value of experiences the Nordic countries have been able to gather prior that will increase.

The Tender

One option for the programs - regardless whether interested in buying or selling - to contract projects is to organise public tenders. In the Nordic context Denmark is at the moment utilising tendering procedures for offshore wind. Box 6 describes how the procedure is organised in the latest ongoing tender.

Box 6. Example of RES tendering procedure.

Case: The Danish tendering procedure for Anholt offshore wind project

The Danish Energy Agency (DEA) is responsible for organising the tender to establish 400 MW of new offshore capacity to the predefined Anholt sea area.

Energinet.dk (the Danish transmission system operator) is responsible for conducting all preliminary investigations on the site of the project. The preliminary investigations include an environmental impact assessment (EIA) and preliminary geophysical/geotechnical surveys of the seabed. This work and the subsequent public hearing will be completed and published before bids have to be submitted. If the EIA cannot be approved, the tender will be cancelled.

Energinet.dk will also be responsible for financing and constructing the substation at sea and connecting the farm to the electrical grid on land.

For potential developers the deadline for placing the bids is 7 April 2010. The winner of the tender will be awarded a concession, permission for further preliminary investigations and a permission to establish the farm, after which the main contractor can finalise contracts and the detailed planning.

The winner is chosen only based on the price asked for kWh of production.

A Joint Nordic purchase programme

A joint Nordic purchase programme could be an option in case the Nordic countries would have difficulties in reaching their targets or purely if searching for least cost solution. The joint purchase programme could operate in two levels:

- The program would develop a joint project in the Nordic area (this option is viewed more in section **Error! Reference source not found.**, **Error! Reference source not found.**.
- The program would search and contract RES-E projects outside the EU area and agree on the terms as required by the Directive. The structure of co-operation would be close to Option A but the notifications would be provided as required when a third country is involved.

Such purchase program would have analogy with national carbon purchase programmes through which countries buy carbon credits for their national compliance. In the Nordic context among others NEFCO[13] would be an organisation qualified to run such program or it could be assigned to a private operator through tendering.

3.3.3 Framework for Joint support scheme

A co-operative framework for a joint support scheme is very topical in the Nordic context due the potential Swedish-Norwegian certificate scheme. The countries' governments agreed in September 2009 on principles for the further work on establishing a joint market for green certificates from 2012 onwards. Box 7 summarises what is known on the scheme at this moment.

Box 7. The joint Swedish-Norwegian support scheme

The Swedish-Norwegian certificate scheme

On September 7th the Norwegian and the Swedish government officially confirmed that they have reached an agreement to further discuss the details of a common market.

The main points were:

- The plan is to have a common market start up from January 1st 2012;
- Sweden's goal was 25 TWh by 2020; and it is expected to be halfway there by 2012.
- Norway and Sweden are expected to have the same goal for the period 2012-2020 - this means 12-13 TWh for each country in this period;
- Technology neutrality, with no size limits;
- New Norwegian hydro production will be included, but there has yet to be a decision made on how old hydro will be treated;
- The public statement concludes that the ministers agree on the necessity of building new transmission capacity.

Other details, like quota obligations are still to be determined.

At the beginning heads to be technology neutral, with only very few exclusions meaning that practically all technologies and installation sizes will be eligible for certificates.

[13] The Nordic Environment Finance Corporation (NEFCO) is an international finance institution established in 1990 by the five Nordic countries: Denmark, Finland, Iceland, Norway and Sweden. It has financed a wide range of environmental projects in Central and Eastern European countries, including Russia, Belarus and Ukraine.

The Directive does not delimit the structure of the support scheme or how the green value produces should be distributed among countries. The only thing the Commission requires is the establishment of a distribution rule how the production under the scheme is divided between the countries and that the countries provide the necessary notifications. As said earlier, the distribution rule can be statistical transfer or a comparable rule defined by the countries. In the upcoming certificate scheme following issues must be considered:

- The burden sharing and pros/cons for both countries
- Transition rules - important to decide which support existing plants are eligible to receive
- What kind of hydro power is eligible for support?
- A well functioning transmission net is necessary for a common electricity certificate market to work properly and contribute to security of supply in the Nordic market
- The yearly quota obligation (a high quota the first year would create a steep investment curve).

4. Scenarios under Nordic RES Flex-Mex schemes

In this chapter the opportunities for co-operation are analysed from the country RES-E potential and cost perspective. The emphasis is in scenarios where the Nordic countries utilise the Flex-Mex within the Nordic countries. The effect of four Nordic co-operation scenarios and the location of new RES investments within these scenarios are analysed. A significant amount of the new RES utilisation is expected to concentrate on power production. Hence, the analysis covers only electricity.

By and large, RES consumption can also be increased in heating and consequently and scenarios in this section should be considered illustrative. Countries are likely to promote use RES both in electricity production and heating&cooling.

4.1 Model description

It is assumed that Denmark, Finland, Norway and Sweden must increase their yearly RES-E production by a total of 62.8 TWh to reach their RES target. The distribution by country and per technology of the 62.8 TWh required increase is determined by minimising the total cost of production, subject to the constraints in each of the four scenarios. A common constraint for all four scenarios is the assumed potentials[14] (Annex 2). The additional constraints of each scenario are as follows:

- **Scenario A:** No flexibility in meeting the national RES-E targets, i.e. each country has to rely solely on domestic measures.
- **Scenario B:** 20% flexibility is allowed, e.g. 20% of the required increase in new RES-E production originate abroad
- **Scenario C:** No flexibility for Finland and Denmark, while Sweden and Norway have a joint target, which is the sum of their domestic RES-E targets
- **Scenario D:** Finland and Denmark have a joint target, Sweden and Norway have a joint target, no flexibility between the two joint targets

It is further assumed that subsidised price of electricity may vary by country and by the type of electricity generation technology. However, all producers within a single country using the same technology are assumed to face the same price.

[14] The estimated potentials are based on the latest, publicly available information. A challenge for the data is that the estimates available from different countries do not make the same background assumptions thus also the presented outcomes are subjects to this.

The cost of production is based on the low-end and high-end estimates of the minimum subsidised electricity price that satisfies the WACC requirement, for given low-end and high-end estimates of the CAPEX and OPEX (Annex 3)[15]. We assume that costs increase linearly as a function of the share of the technical potential. Thus, to realise half of the technical potential of e.g. offshore wind in Norway, the subsidised electricity price must lie halfway between the low-end and high-end estimate.

It should be noted that the analysis does not take into account grid reinforcement or grid extension costs caused by RES-E investments. However, in Section 4.3.5, we analyse how the results of Scenario A change if electricity produced to fulfil other than the home country's RES-E target incurs a transmission cost. The assumptions behind the analysis are presented in Annex 3. Model assumptions and in Annex 4. CAPEX and OPEX estimates of new RES-E investments.

The RES-E potential estimates are based on publicly available studies. See Annex 2.

4.2 Estimated RES-E potentials for the Nordic countries

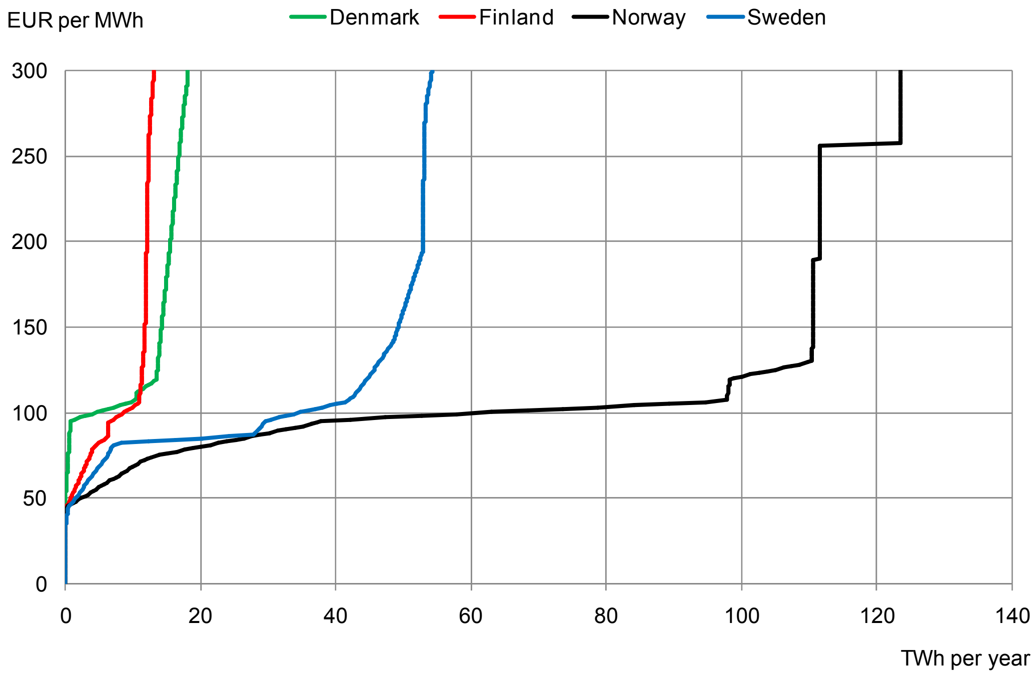


Figure 16: Long-run marginal cost curves for new RES-E production by 2020

[15] WACC: weighted average cost of capital; CAPEX: capital expenditure; OPEX: operating expenditure.

The Figure 16 on the previous page illustrates the long-run marginal cost curves of new RES-E production in Denmark, Finland, Norway and Sweden. The cost curves are based on the information presented in Annex 2, 3 and 4.

As the figures illustrate Norway and Sweden have by far the largest RES-E potential. Denmark and Finland again are estimated to have less than 20 TWh of new production below price of 150 €/MWh whereas Sweden is estimated to have around 50 TWH and Norway over 100 TWh of production below 150 €/MWh.

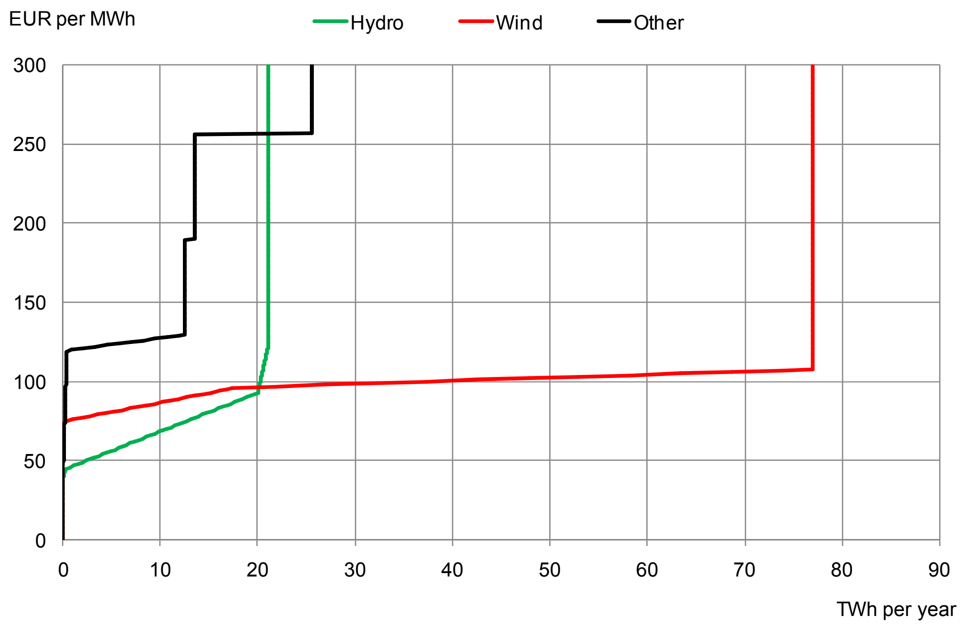


Figure 17: Technology specific long-run marginal cost curves in Norway

The above Figure 17 and Figure 18 on the following page examine the technology specific long-run marginal cost curves for Norway and Sweden more specifically.

Figure 17 and Figure 18 show that wind power dominate both Sweden's and Norway RES-E potential. In addition to hydro (5 TWh) Sweden is estimated to have a fair amount for biogas and biomass electricity generation potential (19 TWh). However, the cost of this potential is higher than the wind power potential in Sweden and Norway.

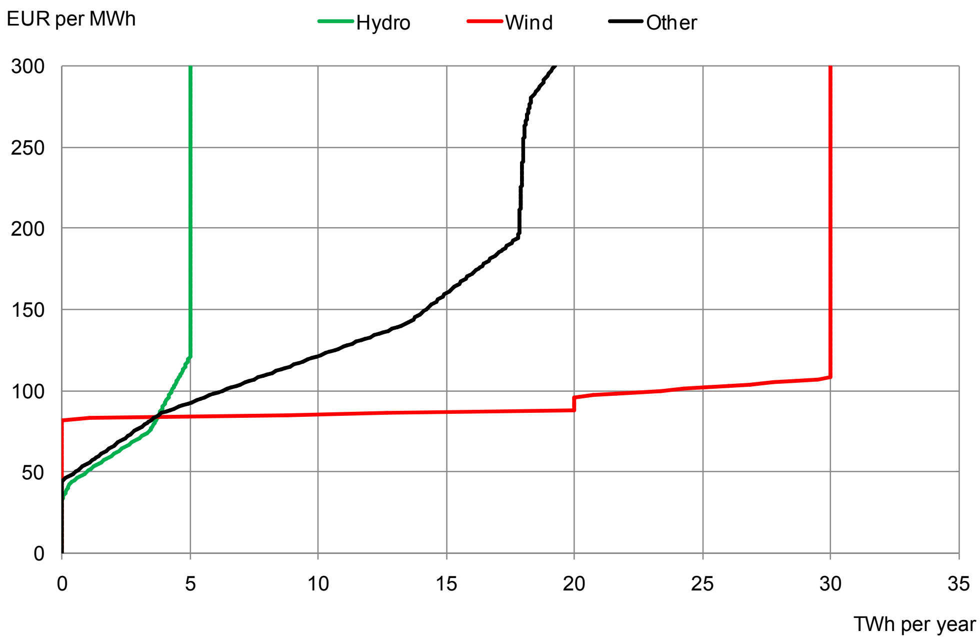


Figure 18: Technology specific long-run marginal cost curves in Sweden

The estimates are subject to many factors thus the scenarios should be read as estimates that give one assumption of the balance between the Nordic potentials. The potential for Norwegian wind power is notable and therefore the estimate is analysed more in Box 8.

Box 8. Wind power potential in Norway.

The Wind power potential in Norway

According to a recent study (Waagaard et al., 2008) on the technical potential of land based wind power in Norway, by 2025 between 5 800 MW (17.4 TWh) and 7 150 MW (21.5 TWh) new onshore capacity could be built. 5 500 MW by 2025 will demand investments of around NOK 82 billion (EUR 9.7 billion), most of which would be invested in 2009-2015; 7 000 MW by 2025 would require close to NOK 106 billion (EUR 12.6 billion).

However, electricity network capacity is an important restricting factor for wind power development in Norway. Additional capacity in the north of Norway would lead to increased export to Sweden, and therefore an increased push on their network capacity, which is already strained. This could lead to import barriers from Sweden, and lower production volume in the northern regions in Norway. Based on the existing network capacity and without dividing between hydro power or wind power, currently there is room for 4 800 MW (14.4 TWh) new power production capacity in Norway.

NVE, the public authority in Norway treating license applications from hydro power plants and wind power plants, has currently 124 wind projects under evaluation. In total, these 124 projects represent 21 500 MW installed capacity, of which 8 200 MW is offshore. Of land based wind power, NVE has currently license projects under treatment representing 13 300 MW (40 TWh). In addition, there are applications for projects that have been complained on, and those that are already given license, but are not built. These represent at total installed power capacity of 1 400 MW (4.2 TWh). In total this accounts 14 700 MW (44.1 TWh), which is three times more than what is realisable by 2015. In almost all regions in Norway there are applications for more MW than what it is capacity for in the central power network. If there is a political interest to build more interconnections - additional to what is already in Statnett's net capacity building plan – it will increase the possibilities for wind power development in addition to figure reported by Waagaard et al. (2008).

Iceland is expected to implement the EU RES Directive and take a comparable increase target. Iceland's electricity production is basically completely based on renewable energy sources already now thus the pressure to increase the share of RES is going to be in heating&cooling and in transport sector. As here the co-operation frameworks concentrate on electricity production the inclusion of Iceland in the scenarios is considered challenging. The increase potential and co-operation constraints are discussed more in Box 9.

Box 9. RES-E in Iceland.

ICELAND: RES-E potential and co-operation constraints

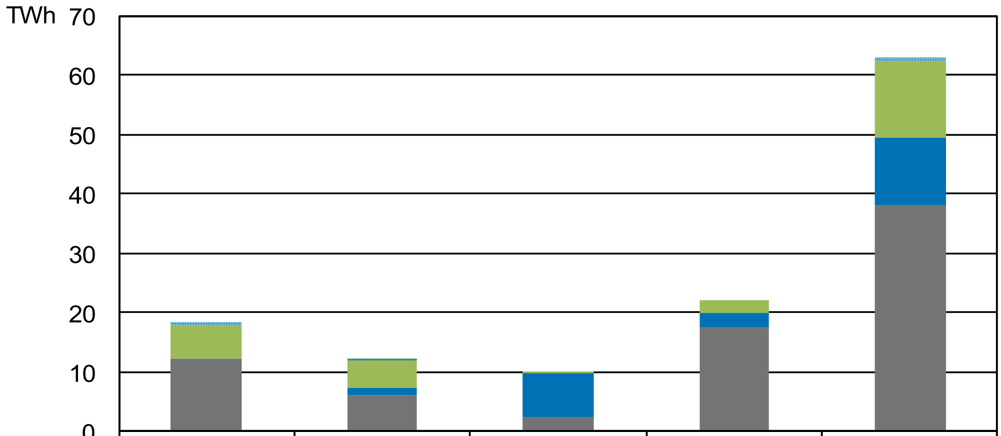
Iceland's electricity generation is based up to 99.9% on renewable energy sources, hydro power and geothermal energy. In 2008, based on information from Landsvirkjun, the total electricity generation in Iceland was 16,467 GWh. Orkustofnun (2006), the national energy authority of Iceland, has estimated that the potential to increase electricity generation based on renewables are as follow.

Hydro power: 18.0 TWh per year
Geothermal: 17.6 TWh per year
Wind power: 1.0 TWh per year

Thus, there is a significant potential to increase RES-E production. However, when considering Nordic co-operation and possible frameworks the main constraint is the absence of transmission lines to other countries that would enable the transport of additional production. Secondly, even if Iceland would host a joint project and would sell only the green value to other countries it would still need to solve what to do with the additional production.

4.3 Co-operation Scenarios for Nordic countries

4.3.1 Scenario A: National measures only



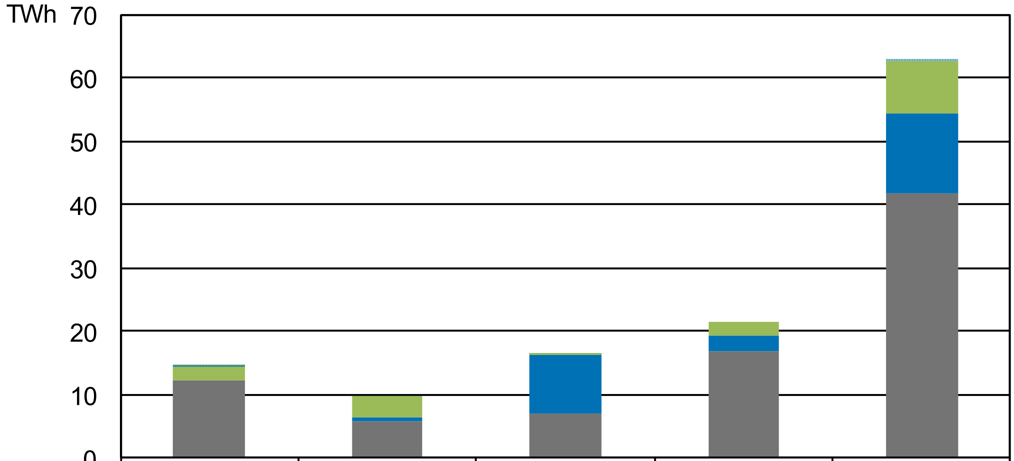
	Denmark	Finland	Norway	Sweden	TOTAL
R&D	0.60	0.03	0.00	0.00	0.63
Bio	5.66	4.94	0.09	2.15	12.84
Hydro	0.00	1.33	7.34	2.48	11.15
Wind	12.14	6.10	2.57	17.37	38.19

Figure 19. Distribution of new RES-E production if the targets are met through domestic measures.

Scenario A illustrates the base case meaning only national measures are taken in reaching the targets. By definition, it is the most expensive way to meet the RES-E targets. Figure 19 illustrates the technology specific distribution of new RES-E production in each Nordic country.

4.3.2 Scenario B: 20% flexibility within Nordic Countries

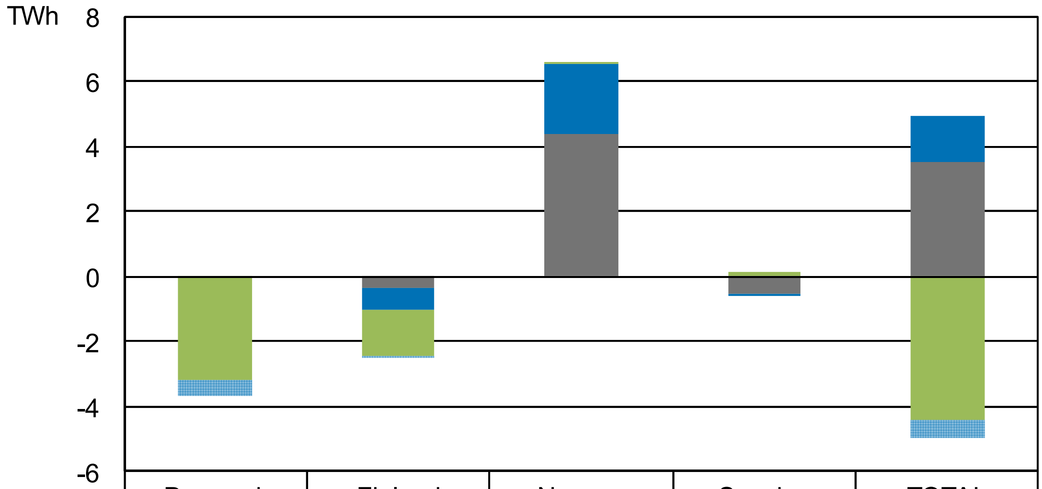
In Scenario B countries meet 80% of the national target with national measures but 20% of the increase comes from joint efforts. Figure 20 illustrates the distribution of RES-E if in contrast to Scenario A, 20% flexibility is allowed in fulfilling the national RES targets. The 20% share is expected to be a least cost solution based on the potential and costs countries are assumed to have for RES-E increase meaning that joint projects or a joint support scheme would direct the new production capacity to where it is cheapest.



	Denmark	Finland	Norway	Sweden	TOTAL
R&D	0.10	0.00	0.00	0.00	0.10
Bio	2.48	3.53	0.12	2.31	8.43
Hydro	0.00	0.63	9.50	2.46	12.59
Wind	12.14	5.76	6.95	16.82	41.67

Figure 20: The distribution of new RES-E production if 80% national measures and 20% flexibility is allowed.

The following Figure 21 presents the difference between Scenarios A and B. It shows that allowing 20% flexibility (Scenario B) compared to no flexibility at all (Scenario A), *increases both wind power and hydro power production in Norway at the cost of biomass based electricity generation in Denmark and Finland*. In absolute figures Denmark's biomass based RES-E production would decrease by 3.18 TWh and Finland's by 1.41 TWh. The size of the cost saving due to this shift is in the order of magnitude EUR 1,300 million per year.

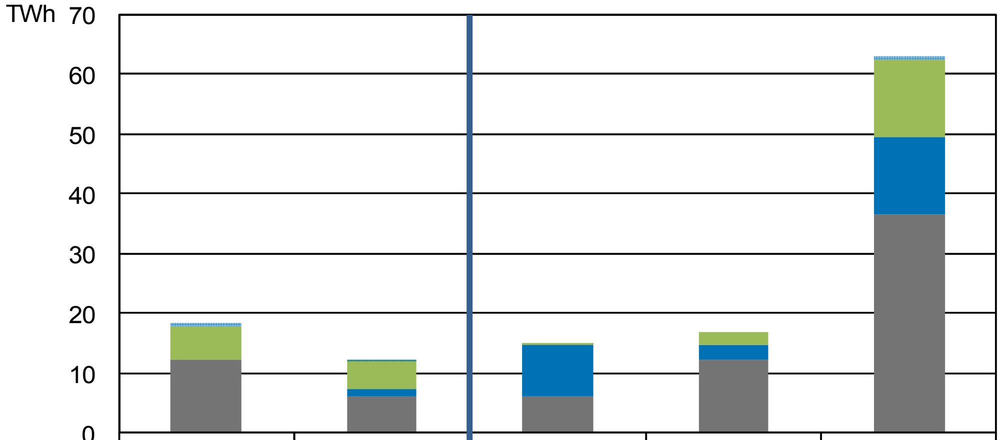


	Denmark	Finland	Norway	Sweden	TOTAL
R&D	-0.50	-0.03	0.00	0.00	-0.53
Bio	-3.18	-1.41	0.03	0.16	-4.40
Hydro	0.00	-0.70	2.16	-0.01	1.44
Wind	0.00	-0.34	4.38	-0.55	3.49

Figure 21: Shift in RES-E production as a result of allowing 20% flexibility in meeting the national targets, i.e. the difference between Scenarios A and B.

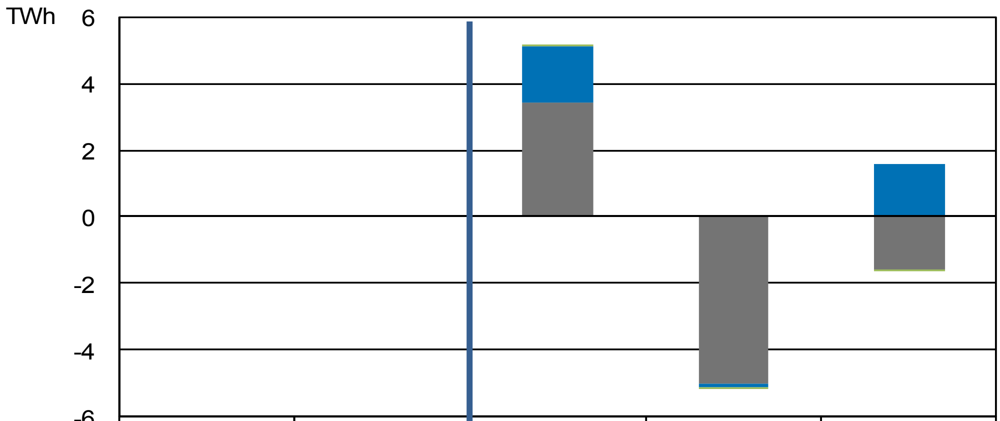
4.3.3 Scenario C: Sweden and Norway form a common market

Scenario C illustrates a situation where Sweden and Norway harmonise their markets but Denmark and Finland again rely on national measures. This scenario is one of the most realisable one due the upcoming joint certificate scheme thus gives a simplified indication on the future situation. Figure 22 illustrates the distribution of RES-E production between Sweden and Norway.



	Denmark	Finland	Norway	Sweden	TOTAL
R&D	0.60	0.03	0.00	0.00	0.63
Bio	5.66	4.94	0.11	2.11	12.83
Hydro	0.00	1.33	9.03	2.35	12.71
Wind	12.14	6.10	6.00	12.40	36.63

Figure 22: Distribution of new RES-E production if Sweden and Norway form a common market while Denmark and Finland rely on national measures.



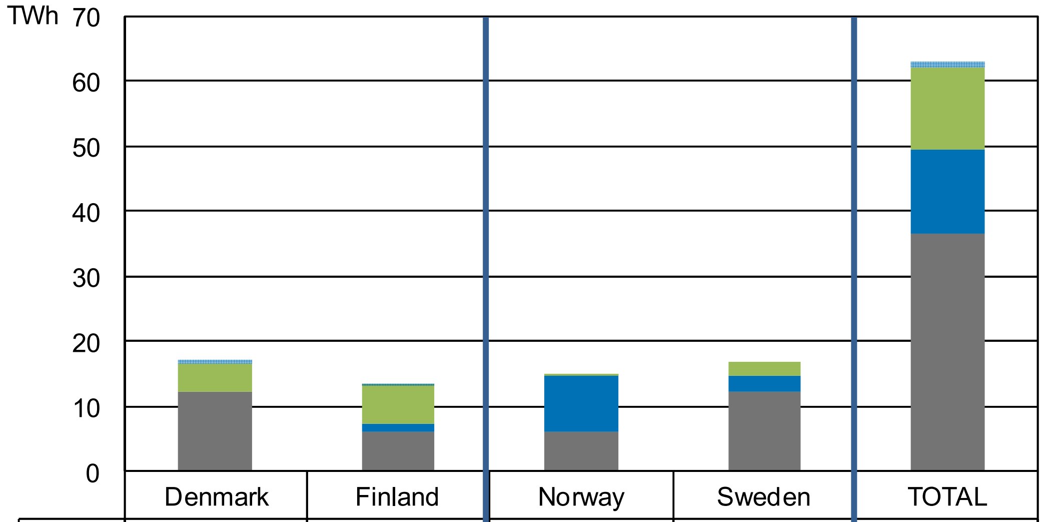
	Denmark	Finland	Norway	Sweden	TOTAL
R&D	0.00	0.00	0.00	0.00	0.00
Bio	0.00	0.00	0.02	-0.03	-0.01
Hydro	0.00	0.00	1.69	-0.13	1.56
Wind	0.00	0.00	3.42	-4.98	-1.55

Figure 23: Shift in RES-E production as a result of a common market between Sweden and Norway, i.e. the difference between Scenarios A and C.

Figure 23 illustrates the difference between Scenario A and C, meaning the difference between national measures and a joint market. The scenario shows that a common market between Sweden and Norway increase wind power and hydro power production in Norway at the cost of hydro power capacity in Sweden. In total, the change is in magnitude of 1.5 TWh between the technologies. The cost saving due to this shift is however not very significant because up to 32 TWh additional RES-production, i.e. the joint target, there is no assumed to be a large difference between the marginal cost curves of Sweden and Norway.

4.3.4 Scenario D: Two separate markets

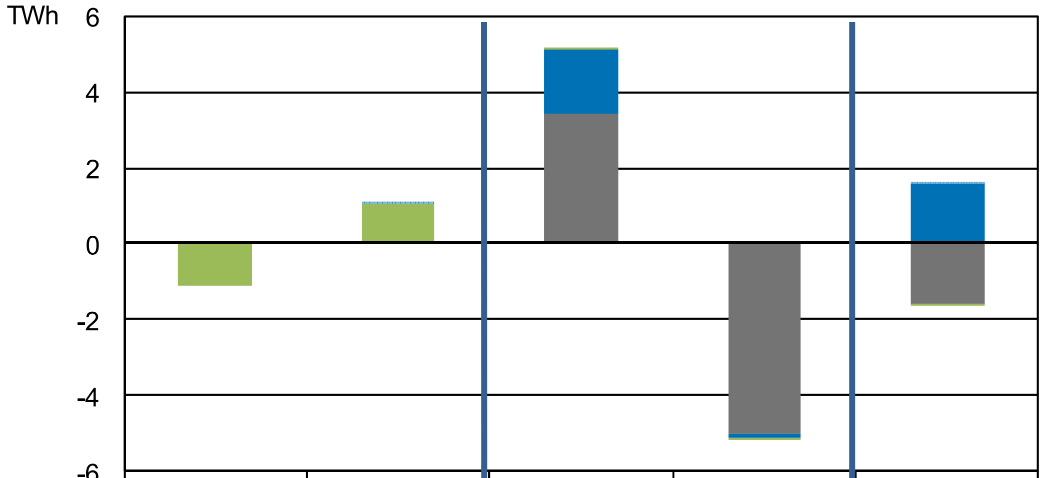
In this scenario it is again assumed that Norway and Sweden for a joint market but, in addition, Finland and Denmark join forces and enter into full co-operation. Figure 24 illustrates the distribution of RES-E production in this scenario.



	Denmark	Finland	Norway	Sweden	TOTAL
R&D	0.60	0.10	0.00	0.00	0.70
Bio	4.54	5.99	0.11	2.11	12.75
Hydro	0.00	1.33	9.03	2.35	12.71
Wind	12.14	6.10	6.00	12.40	36.63

Figure 24: Distribution of new RES-E production if the market is split in two and no flexibility these two submarkets is allowed.

The form of co-operation between Denmark and Finland is not specified – whether it is harmonised support or whether it is full utilisation of joint projects. The following Figure 25 presents the difference between Scenario A and D, meaning cases where countries rely only on national measures and cases where the least-cost solutions within Swede and Norway and again Denmark and Finland are sought. In addition to the shift in production from Sweden to Norway, as in Scenario C, the Scenario D leads to a 1 TWh shift of biomass based production from Denmark to Finland. Whereas the cost saving of the former (Sweden-Norway) is insignificant, as noted in the analysis of Scenario C, the cost saving of the latter (Denmark-Finland) is in the magnitude of €100 million per year. In case Finland and Denmark would allow flexibility only partially (for example implement single least cost joint projects) the impact would be similar but in smaller magnitude – use of biomass would increase in Finland but on the other hand there would be cost savings.



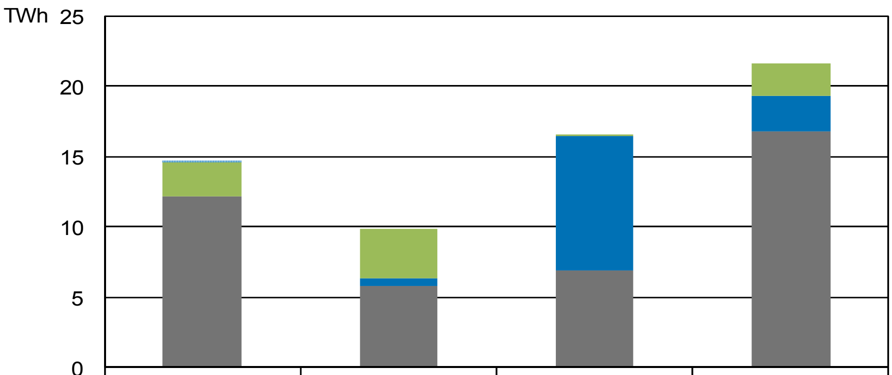
	Denmark	Finland	Norway	Sweden	TOTAL
R&D	0.00	0.07	0.00	0.00	0.07
Bio	-1.12	1.04	0.02	-0.03	-0.08
Hydro	0.00	0.00	1.69	-0.13	1.56
Wind	0.00	0.00	3.42	-4.98	-1.55

Figure 25: Shift in RES-E production as a result of a common market between Sweden and Norway, and Finland and Denmark.

4.3.5 Sensitivity to transmission costs

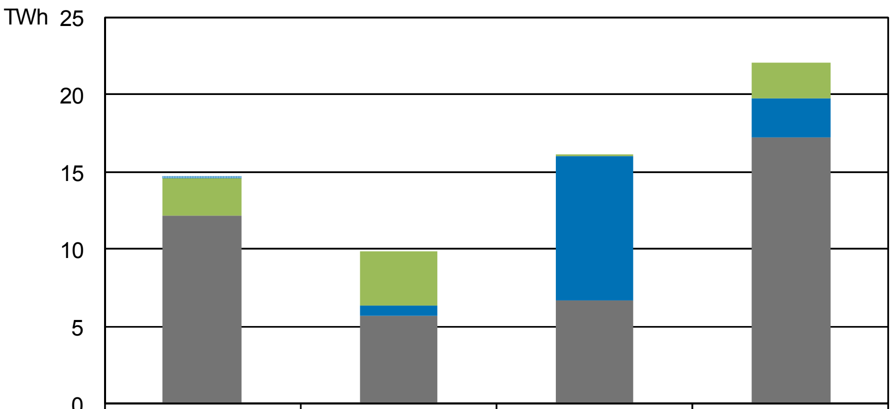
Figure 26 shows how the distribution of new RES-E production in Scenario B (20% flexibility) changes if we assume that electricity produced to fulfill other than the host country's RES-E target incurs a transmission cost of 5 EUR per MWh. For comparison, according Krohn et al. (2009), for wind energy penetrations of up to 20% of electricity demand, system operating costs increase by approximately EUR 1-4 per MWh of wind generation.

No transmission cost included



	Denmark	Finland	Norway	Sweden
R&D	0.10	0.00	0.00	0.00
Bio	2.48	3.53	0.12	2.31
Hydro	0.00	0.63	9.50	2.46
Wind	12.14	5.76	6.95	16.82

Transmission cost included



	Denmark	Finland	Norway	Sweden
R&D	0.10	0.00	0.00	0.00
Bio	2.48	3.54	0.11	2.29
Hydro	0.00	0.63	9.37	2.50
Wind	12.14	5.75	6.68	17.21

Figure 26: Distribution of RES-E production in Scenario B with and without transmission costs for electricity produced to fulfill other than the host country's RES-E target.

We see that transmission costs, as defined here, have *a negligible effect on the distribution of RES-E production*. The only noticeable effect is that with transmission costs 0.4 TWh less electricity will be produced in Norway to meet Sweden's RES-E target. Instead, Sweden will increase its wind power production with 0.4 TWh per year.

4.3.6 Conclusion for Scenarios

By definition, utilising larger renewable energy potential and using flexible mechanism increased cost-efficiency of reaching targets. However, renewable energy has also other values than reaching targets – they improve security of supply and create new jobs. A balance between other objectives of renewable energy consumption and targets has to be found. Based on the scenario analysis above, one can conclude that significant cost-savings can be obtained with flexibility – only 20% flexibility would bring an annual cost saving of 1,300 million EUR. The common Swedish-Norwegian certificate market would on the other hand change location of the new investments, but the cost-savings would be moderate. This is due to fact that the cost and potentials in these countries are close to each other. However, this does not diminish the fact that larger market would be able to capture and adapt other challenges related to renewable energy implementation. For example, if there would be significant grid (as there is) bottlenecks that do not enable investing in low cost potential the number of remaining sites that do not have these restrictions would be larger.

4.4 Case study: a potential joint Nordic project: 1000 MW offshore wind power

The Scenario B showed that allowing 20% flexibility from 0% flexibility, increases hydro power production and wind power production in Norway at the cost of biomass based electricity generation in Denmark and Finland. As a result the cost of reaching the joint RES-E target for Sweden, Norway, Denmark and Finland is reduced by approximately EUR 1,300 million per year.

The increase is wind power generation in Norway as a result of this increased flexibility is 4.38 TWh per year and the increase in hydro power generation is 2.16 TWh per year. Assuming full load hours of 3000 per year, as is done in the analysis for offshore wind in Norway, the expected increase in wind power generation translates into a capacity of 1500 MW of new wind turbines. Plausibly, 1000 MW of this could be carried out as a Joint Project between the Nordic Countries. This would realise a large part of the cost saving stated in the paragraph above, of allowing 20% flexibility.

Figure 27 illustrates the framework for the joint project. The countries form a political framework agreement and give an operational mandate to an entity to establish a purchase programme. Norway (due lowest cost according to model) takes the initiative to specify location of the project and the needed site specifications and further authorises the purchase programme to organise a tender on the construction of the plant. Here, the Danish offshore tendering procedure that was presented in page 30 offers a valuable example of the role and responsibilities of the participants and the authority.

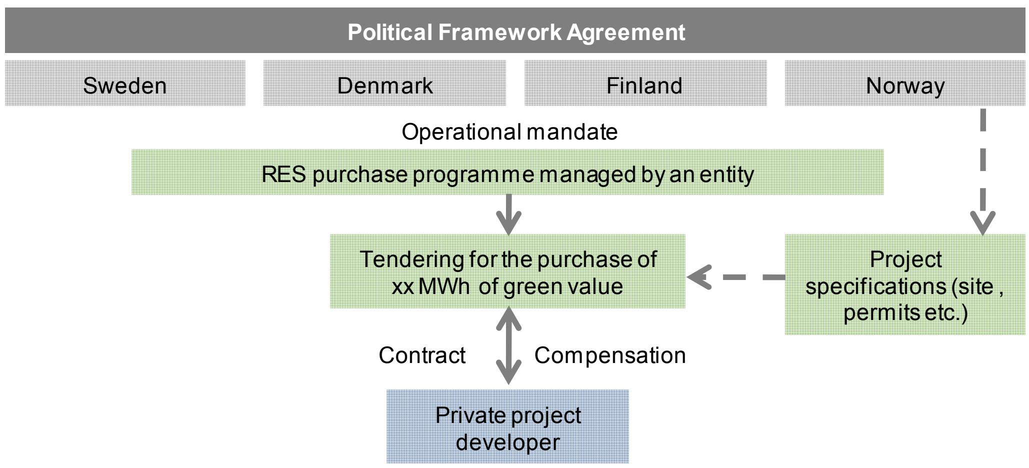


Figure 27. Framework for a joint Nordic wind power project.

The countries commit to purchase agreed amount of the green value of the production and the electricity production is sold to the market. The compensation and financing of the project can be executed in different ways. The following Table 4 illustrates alternatives for it.

Table 4. Alternatives for financing a 1,000 MW offshore wind park as a Joint Project between the Nordic Countries.

Type of financing	Description
Wind park is financed and operated by a entity set up by the Nordic countries	The Nordic countries set up a legal entity, and provide sufficient capital for it. The entity acquires the wind turbines and other relevant infrastructure for least cost, through tendering. The entity operates the park, covers the operating costs, and distributes the revenues from electricity generation back to the Nordic countries. The green value generated by the wind turbines is split between the participating Nordic countries.
Privately owned but receives investment support from the Nordic countries	The wind park is privately owned, but receives a fixed amount of investment support. The amount of support is minimised trough a tendering procedure. The green value generated by the wind turbines is split between the participating Nordic countries,
The Nordic countries commit to buy the green value generated by the park for a minimum price from a private operator	The wind park is privately funded, but the Nordic countries commit to buy the green value generated by the park for a minimum price, say, for a period 15-20 of years. The operator carries the electricity price risk. The park is excluded from the national support scheme for RES-E generation in Norway. This minimum price is sought through tendering. The green value generated by the wind turbines is split between the participating Nordic countries.

The third alternative is the most realistic. Since wind power in Norway is the least cost alternative, after hydro power in Norway, to minimise costs of reaching the RES-E targets, it is beneficial for Sweden, Denmark and Finland to acquire wind power from Norway. Thus, the split could be, for simplicity, such that each country commits to buy one fourth of the green value that the 1 000 MW wind park generates. It is assumed Iceland is self-sufficient in electricity generation from renewable, because of the large untapped hydro power and geothermal potential.

The Scenarios presented show that co-operation and the utilisation can create cost savings and lead to innovative solutions. However, the co-operation structures and consequences need to be considered carefully prior implementation. The following chapter heads to consider the benefits and challenges such co-operation can evoke.

5. The benefits and challenges of Nordic Flex-Mex co-operation

5.1 Financing of renewable energy projects

The type of support is provided to RES generation is likely to have a major effect on the financing of new investments. The risk profile of project within a feed-in tariff scheme is very different to a project within a green certificate scheme. Figure 28 illustrates the cumulative probability distribution of the electricity price for a project that is guaranteed a fixed minimum electricity price compared to a project that on top of the market price is entitled to green certificates, whose value is subject to change.

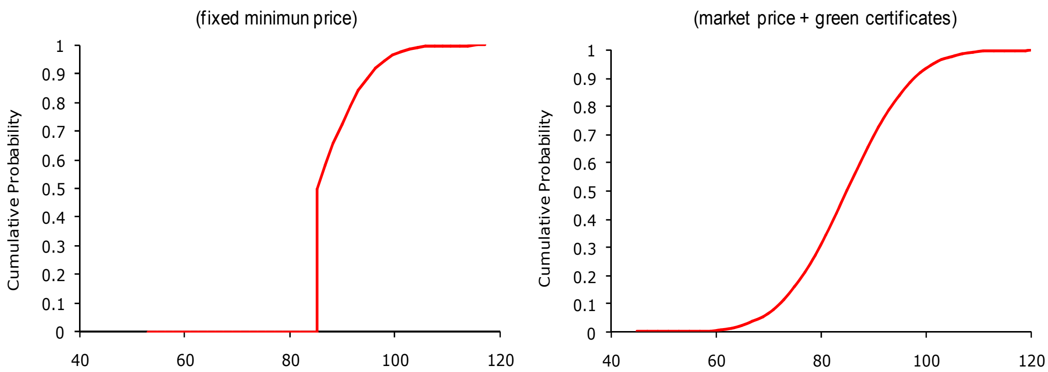


Figure 28: Cumulative probability distribution of the electricity price for a project within a support scheme that guarantees a minimum price compared to a project within a green certificate.

As a consequence, projects with a guaranteed minimum price may receive financing for a lower cost than projects more vulnerable to the fluctuations of the price of electricity and green certificates. This distortion caused by the type of support scheme should be taken into account in utilisation of the joint project mechanism in the Nordic context, because the joint project mechanism may link the diverse national support schemes in a way, which creates competition between them.

By and large, there will be renewable energy projects that are not profitable with domestic RES support schemes but other countries might still be interested in purchasing their renewable value. In other words, flex-mex could be seen an alternative financing sources for some projects. There are no clear rules, whether the buyer of the renewable value would purchase production (MWh), capacity (MW) or equity of the project.

5.2 Electricity system requirements

The electricity system requirements; energy supply security, need for balancing power and grid expansions/enhancements must be taken into consideration when planning to increase the level of co-operation between countries. Power plants; electricity consumers; transmission and distribution networks connecting the consumption and production sites together, form the electric power systems. Power system reliability has to be at a very high level in order to avoid electricity system failures, which are costly and far-reaching. The correlation of wind power production and electrical load plays important role, when considering the power system effects of a variable production forms such as wind power - wind power production brings more variability and uncertainty to the power systems.

However, increase of new production capacity in the system has possible both positive and negative impacts on power system reliability and efficiency. The characteristics of power systems are different in every Nordic country and large amounts of variable production such as wind power usually turn from positive impacts to negative at some stage of the penetration level. Large balancing areas and aggregation benefits of large areas help in reducing the variability and forecast errors of wind power as well as help in pooling more cost-effective balancing resources. For the fault-ride –through and grid voltage maintenance perspective in existing wind power projects, modification of grid codes for connection and operation of wind power farms in the high voltage grid have proved essential. In the Northern regions winter season offers usually highest wind generation. Energy consumption is also highest at that time, which has positive impact on the utilisation of the existing transmission capacity. It can be expected that increasing wind power in the Nordic countries will increase electricity transmission between the countries and regions.

There are several issues to be taken into consideration in the power and grid systems when planning to increase wind power production in the system significantly:

- Variability and predictability
- Grid code requirements
- Wind turbine capabilities
- Transmission adequacy and efficiency
- Grid reinforcement and system stability
- Terrain topography and local wind structure

The system impact of wind power to the power system:

- Voltage management (reactive reserve)
- Reserves (primary and secondary control)
- Transmission/distribution losses
- Cycling losses
- Replaced and Discarded energy

- System reliability

Wind power predictability has an important role in the system integration of large scale wind power. Predictability for time like six hours horizon ahead, gives important information and time to react to varying wind conditions. In large areas, average errors in load forecast are about 1.5-3% of peak load corresponding to an error about 3-5% of total energy when forecasting one day ahead. For example, in west Denmark the estimated costs due to forecast errors day-ahead has been between 1.2- 2.6 €/MWh. (Holttinen 2004)

Increasing balancing requirements depends on region size relevant for balancing, initial load variations and how concentrated/distributed wind power is located. If wind power penetration would be 20% of the gross demand energy, system operation cost would be, according the studies, between 1- 4 €/MWh, which are around 10% of the wholesale value of the wind energy. In Nordic studies it has been estimated that required reserves correspond about 2% and 4% of installed wind power capacity at 10% and 20% penetration levels in the whole Nordic sector. This could be two times bigger for a single country in the Nordic region. An increase of required reserves means production about 0.33 TWh/a and costs of 0.1-0.2 €/MWh at 10% penetration level and 1.15 TWh/a and 0.2-0.5 €/MWh at 20% penetration level. Costs will depend from the allocation and actual use of the reserves. Usually in low wind power penetration cases, the increase in reserve requirements can be handled by the existing capacity and only use of dedicated reserves or increased load plant requirement causes extra costs. (VTT 2007)

The Greennet-EU27 project estimated the increase in system operation costs as a result increasing amount of wind power in Sweden, Denmark, Finland and Norway. The base case has a “most likely” forecast of wind power capacities in 2010 for all countries and in the other two cases it was estimated that wind account 10% and 20% of annual electricity demands in different countries (excluding Denmark, where respectively has been used in both the 10% and 20% cases, the forecasted wind power capacities for 2015 equal to cover approximately 29% of the annual electricity demand).

Table 5. Estimated increase in the system operation cost €/MWh.

	Denmark	Finland	Norway	Sweden
Base	-0.02	-0.15	0.15	-0.05
10%	0.45	0.25	0.2	0.22
20%	0.8	1.35	0.45	0.65

Previous studies highlight the following issues:

- In countries, where there is large amount of the hydropower (like Norway), the power integration cost are lower than in thermal dominated countries (like Denmark).
- Denmark has a large share of wind power and excellent transmission possibilities to neighbouring countries, meaning that costs of wind power integration are lower than for example in Finland.

- When capacity of wind power increase in Finland, Sweden or Norway, the integration costs of Denmark will increase, because the export opportunities are decreasing.

Building significant amount of new wind power capacity can bring needs for grid reinforcements to handle large power flows and maintaining stable voltage. When planning wind power in areas with limited power transfer capacity, conservative assumptions may lead to unnecessary strict limitations on the possible wind installation. The cost of grid reinforcements varies from the load locations of wind power plants and grid infrastructure. According studies the grid reinforcement costs can vary from 50 €/kW to 160 €/kW. (VTT 2007)

Some points of recent studies (VTT 2007):

- A study concentrating in offshore production in the Netherlands estimated that grid reinforcement cost were 60.11 €/kW for 6000 MW for offshore wind.
- According to a Swedish case study there is no reason in economic way to build a new transmission line for 3200-4000 MW enhancement of wind power to just reduce the energy spillage.
- According to a study of specific system in Norway points out that there is no remarkable reduction in income from energy sales compared to an ideal non-congested case, by applying coordinated operation of the wind and hydro power plants, when wind power has installed up to 600 MW. It is concluded that power system co-ordination allows surprisingly large amounts of wind power.

Impacts of wind power to the transmission and distribution losses can increase or decrease, depending situation related to the load. According to study in the UK, the extra transmission cost can be 2 €/MWh in the north at a wind power penetration level of 20 %. (VTT 2007)

In the case of wind power, there will be discarded energy and the level depends on the operational strategy of the wind power. Level of discarded energy can be around 10% of the total wind power produced at the 20% yearly consumption level. (VTT 2007)

Large scale wind power may have an effect to the losses of thermal and hydropower production. Large variation in wind power output can affect the conventional power plants less efficiently. This is because planning the starts and shutdowns of slow-start units is more complicated when the intermittent output from wind power is included. Extra starts and shutdown costs to the thermal production, can be 0.6 €/MWh and 0.5 €/MWh at wind power levels of 10% and 20%. Especially in the spring flood time wind power may have influence to the hydro production losses. In the case where Nordic countries would have 12% penetration and 46 TW/a of wind production, the losses due to increased floods can be 0.5-0.6 TW/a, meaning 1% of the wind power production. (Holttinen, 2004)

Capacity credit is the contribution that a given generator makes to the overall system adequacy. The capacity value of any generator is the amount of additional load that can be served at the target reliability level with the addition of the generator in question. The capacity credit of wind power means things such as:

- Can wind substitute for other generation in the system and what extent?

- Is the system capable of meeting a higher (peak) demand if wind power is added to the system?

Wind power provide some additional carrying capability to meet projected increases in system demand and this contribution can be up to 40% (in situations with low wind penetration and high capacity factor at times of peak load) and down to 5% (in higher wind penetrations, low capacity factor at times of peak load or if regional wind power output profiles correlate negatively with the system load profile) of installed wind power capacity. At higher wind penetration level the share of wind capacity credit compared to the installed capacity is falling. Capacity credits is also depending of the geographical location and smoothing. (VTT 2007)

It is notable, that the conducted case studies are not easy to compare due to different methodologies and data used, as well as different assumptions on the interconnection capacity available.

5.3 Grid issues

Grid issues are one of the biggest obstacles in building sufficient amount of renewable energy. Who will get access to grid? Is it going to be a first come, first serve system, or should developer take part of the cost? All these questions must be answered in order to facilitate for a large scale development of renewable energy in the Nordic area and this requires an extensive dialogue between the Nordic countries and stakeholders. The ambitious RES targets will make this issues necessary to be addressed regardless of if there is going to be a harmonised system between the countries for renewable energy or a non-harmonised national systems. Important issues to take into consideration in relation to the flexible mechanisms are access to grid, energy transmission capacity and regulating capacity. The Article 17 of the RES Directive states following:

Member States shall take the appropriate steps to develop transmission and distribution grid infrastructure, intelligent networks, storage facilities and the electricity system, in order to allow the secure operation of the electricity system as it accommodates the further development of electricity production from renewable energy sources, including interconnection between Member States and between Member States and third countries.

Member States shall also take appropriate steps to accelerate authorisation procedures for grid infrastructure and to coordinate approval of grid infrastructure with administrative and planning procedures.

In the case of a joint certificate system between Norway and Sweden the answer to question who should bear the costs in investments in the grid, is not so obvious, and detailed calculation on who has the benefit of a new power-line must be carried out. Even under this assumption, the burden sharing between the countries will be a difficult question to solve. A common **transmission system operator (TSO)** in the Nordic area could of course make matters like this easier to solve.

In order to analyse the challenges of using RES Flex-Mex we interviewed representatives of the TSOs. In following sections, the main findings for each country are summarised

5.3.1 Sweden

The Swedish government has given the Swedish TSO the Svenska Kraftnät task to renew the regulatory framework around the responsibility for reinforcement of the national electricity grid and grid connections for large power plants. The target is to reduce the barriers of grid connection for further development of renewable energy. The main tasks of Svenska Kraftnät are building and maintenance of the electricity grid, to connect new production units to grid and make sure that the market works regardless of the energy politics.

Sweden does not have a specific national strategy for the electricity grid to meet the 2020 goals for renewable energy. The 2020 goals are valid but have not been concretized. According to Swedish legislation Svenska Kraftnät shall own lines within the national transmission grid (400 and 220 kV) and have a decisive influence on connections to other countries. Svenska Kraftnät has no specific position when it comes to private investments in the electricity grid in other countries in Europe. In the Nordic countries we have a different model compared to central Europe and Svenska Kraftnät does not see any important challenges today when it comes to incentives for investments in the grid in Nordic countries. In the rest of Europe, the main incentive to expand the grid is not to be able to connect more renewable energy to the grid, but the main challenge is to facilitating for an improved electricity market and trade.

Svenska Kraftnät sees the importance of continuous work to improve the Internal Energy Market. There are several challenges related to the electricity grid and the interconnectors to improve the market integration in Europe. However, it is important that the EU pursue the Member States to implement the second and third energy package before they go on with a new strategy.

When asked whether it is possible and realistic to reach the renewable target in regards to the national grid, Svenska Kraftnät says that it is challenging but possible. The challenge is to make politicians and other stakeholders fully aware that the challenge is not the power plants that takes time to be built, but the expansion of the grid. To get the concession rights to expand the grid requires a lot more time than to get concession to build a new wind farm for example.

Svenska Kraftnät finds the international co-operation on grid and system responsibility issues very good and valuable. The cooperation through ENTSO-E[16] works well and there is a lot of learning and competence sharing in this co-operation.

When it comes to the planned common Electricity Certificate market between Norway and Sweden, Svenska Kraftnät also finds this future co-operation very important. It will give a more liquid market and more effective use of the resources. A better use of the energy resources also means lower costs related to the expansion of the electricity grid in both countries.

Elforsk (2008) estimated that in a longer perspective the Swedish electricity production could be maximum 30% from wind power due to grid restrictions. Wind-mill farms access

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[1616] European Network of Transmission System Operators to transmission of energy and regulating power are important factors which often are highlighted in various discussions.

Energimyndigheten have stated that the target of 30 TWh wind power is ambitious and that it could be reduced.

5.3.2 Norway

A representative of the Arbeiderpartiet stated that Norway needs an ambitious policy when it comes to build new cables abroad. The Norwegian party Høyre has stated in its party program that they support that Norway build more network connections to other countries to export renewable energy from Norway. A survey done by the magazine Teknisk Ukeblad shows that parties like FrP, Venstre, Arbeiderpartiet and KrF have a positive view on extending the transmission network. Other political parties are vaguer in their statements on this area. The Industry association Norsk Industri also share this position. They believe Norway will experience continental power prices, but the question is how the development will be. According to Norsk Industri large volumes of wind power will lead to low electricity prices in some areas from time to time and the average price will decide the speed of out phasing of coal. Nuclear power will also play an important role together with the development in industry in Norway and Europe in general. Norsk Industri is also positive for exporting of power to Europe as long as the power balance is not weakened. In addition, Norway has to decide how new cables are going to be financed.

The Norwegian TSO Statnett believes that substantial grid improvements are necessary in order to reach EU RES targets in a sustainable way. Statnett's national strategy for net expansion to meet the 2020 goals is described in the Grid Development Plan for the Central Grid 2009 (see: www.statnett.no).

With regard to the grid challenges in relation to renewable energy, the main domestic challenges are as follows:

- The time dimension – developing new power lines (planning, permits, building etc) is a lengthy process
- The power balance – ambitious targets in all the Nordic countries yields a large power surplus in the Nordic region.

In terms of expanding the grid capacity towards Europe, there is a problem that certain European TSOs have weak incentives to develop new interconnectors and cross-border connections.

In terms of how to increase grid investments in the EU, allowing a higher return on new grid investment would help. At the same time, it is important that the TSOs get cross-border connections defined as part of their core activity.

In terms of burden sharing, percentage-increase solutions are arbitrary and pointless. International co-operation between TSOs is seen important and it primarily realizes through the ENTSO-E. Overall, reaching the renewable target is highly dependent on what extent the governments are willing to facilitate new grid investments.

5.3.3 Denmark

The Danish TSO Energinet expects in 2025 the share of renewable energy in the grid will approach 50%. Today's figure is around 27 % meaning that the Energinet is looking to almost double this figure and this poses a tremendous challenge to the grid.

There are two dimensions to Denmark's national strategy to meet the net expansion required to reach the 2020 goals; the internal grid and the interconnections with other countries. In terms of international interconnections, Energinet have currently four projects.

- 1. Skagerak interconnector (one of the 5 priorities outlined by the Nordic TSO organization Nordel in 2004)
- 2. Increased capacity between Western Denmark and Germany.
- 3. A direct connection between Denmark and the Netherlands (named COBRA Cable). Energinet are considering possibilities to incorporate this connection in a future North Sea offshore grid (for offshore wind). This will however depend on what type of direct current is chosen. If the right type is chosen the COBRA interconnector can be connected directly to a North Sea offshore grid.
- 4. Kriegers Flack in the The Baltic Sea. Project together with Vattenfall and the German TSO. Germany, Sweden and Denmark all own parts of the Baltic Sea with potential for offshore wind. Energinet are researching a common grid solution that will apply to the offshore wind facilities in the area of the Baltic belonging to all three countries – this solution might also function as an interconnector between the three countries.

Internally, an important issue in Denmark is the connection capacity between the Western and Eastern regions – the Great Belt interconnector - also one of the five Nordel priorities outlined in 2004. It has also been decided that a potential restructuring of the transmission network is to be mapped. In the 132-150 kV network – all areal cables to be removed over the next 20 years. This plan will at the same time completely restructure this part of the transmission grid. By and large, it has double benefit as it also contributes to the grid being able to handle increased shares of renewable energy. In the 400 kV network Energinet has a number of ongoing projects and more in the pipeline. All of these plans support the EU RES 2020 targets. Denmark and Energinet have thus gotten far in developing our strategy to face the grid challenges with regard to EU 2020, but reaching the targets requires a massive investment level.

In order to increase grid investments in the EU, allowing a higher return on new grid investment is a textbook option that seems obvious to be applied. The EU's Third Energy Package supports unbundling of production and transmission activities to avoid situations where a company has disincentives to invest further in the grid. The Nordic countries lead the field in this area. In continental Europe, there are companies that own both production and grid – dissolving these is the point of the Third Energy Package. Ownership issues are central – naturally, Energinet is a proponent of the Danish/Nordic model with public ownership of infrastructure. A key issue here is that a government as the owner of the grid might not require that high rate of return on investment that they would want to invest in the grid. This is a flammable subject in some countries, but in the Nordic region there seems to be a harmonized picture of what the ideal solution is.

Will a fourth EU package for market integration be required? According to Energinet: probably yes. But in the existing packages that regulate electricity trading, there are guidelines for market integration that are in progress but not complete implemented. One should wait to see the impact of these guidelines before progressing with further packages. (This opinion might be personal and not necessarily the stance of Energinet)

With regard to burdensharing of grid investments – some propose a solution where each country is obligated to strengthen the internal and external grids by x and y %. However, this is a flawed solution as it does not take into account efforts already made. In relation to the five priorities outlined in the Nordic region in 2004, Energinet have gone far in tackling grid challenges – especially compared to some parts of Central and Eastern Europe. It is meaningless to talk about percentages. Instead one should focus on where there is a need for new grid solutions, and not argue that each country has to strengthen the grid by x or y %. ENTSO-E is obliged by the regulators and/or the EU Commission to outline a grid development plan for this purpose – focusing on need rather than equal burden sharing. There might be scenarios where a grid solution in one country might be beneficial to other countries as well – for instance, if a building a particular cable between Norway and Denmark has benefits for other countries – in such cases; there could be a discussion about sharing the financial burden with all the countries benefitting from the investment. Benefits should equal cost, and one should not demand that each country does x or y % physically, instead look at need and co-operate on financing.

In terms of international co-operation, Nordic co-operation on these issues has functioned as an ideal model for co-operation. The analyses made in this co-operation are of a socio-economic rather than a business-economic nature. The Nordic co-operation has been excellent and Energinet hopes to be able to take this to the Western/Northern European level – through ENTSO-E and the working group consisting of the Nordic countries, Germany, the Netherlands and Poland.

In conclusion, it is definitely possible to reach the renewable target in the national grid. Denmark is one of the countries that have the highest target – 30 % in the directive, and Energinet is aiming for 50 % in the electricity grid – and Energinet are comfortable that this is possible. It is going to be both difficult and expensive but Energinet is already initiating projects that support this target, and it is Energinet's clear opinion that the target is viable.

3.4 4 Grid issues in Finland

A bottleneck for increasing domestic RES-E production in Finland is the availability of balancing power, according Fingrid, the Finnish electricity grid operator. Grid capacity, on the other hand, is not a bottleneck, since the Finnish grid is reinforced continuously, says Fingrid.

The need for additional balancing power arises from the variability of wind power. Wind power is expected to represent a major share of new RES-E production in Finland, as the scenarios in the Section 4.2 shows. Dynamically, the challenge is that tightening the regulation emission of CO2 emissions, and the emissions of other airborne pollutants, on one hand, increases the share of RES in electricity generation, and on the other, restricts the construction of new balancing power, if the balancing power uses fossil fuels. One solution, according to Fingrid, is to make the private demand more flexible, either by pricing or by command-and-control, so that part of it could be switched of depending on wind conditions. In practice, the load shedding could be accomplished by smart grids.

Scenario B in Section 4.3.2 shows that allowing 20% flexibility in reaching the national RES-E target would shift approximately 2.5 TWh of new RES-E production abroad from Finland. If this production is imported back to Finland, it is likely that the transmission capacity between Sweden and Finland must be strengthened. Otherwise the functioning of the Nordic electricity market may suffer. Doubling the transmission capacity between Finland and Sweden will take between 7 and 10 years, according to Fingrid. Disputes over conservation areas, if any, will add further delay the increases in transmission capacity.

Thus, from an international perspective, the bottleneck is the existing international transmission capacity. In general, building transmission lines is slower than constructing power plants. In addition, when electricity is transported long distance, e.g. from offshore wind park on the Norwegian coast to Finland, the question of the security of supply arises. What happens if a transmission cable is damaged? Should there be a redundancy in the transmission capacity? If there is no redundancy, what type of domestic reserve capacity is needed to cover the deficit?

5.3.4 Conclusions

Based on the views of the Nordic TSOs one can conclude that grid issues are probably the most important single item that has to be addressed in order to support a large scale development of new renewable energy in the Nordic area in general or in each country. Grid issues must be evaluated as an integrated part of the question of harmonisation of renewable energy in the Nordic region - not after there is a decision on a harmonised support system for renewables or large scale joint projects. Until then, grid problems remain mainly as a national question.

A detailed calculation of the grid requirements requires a vast amount of data, and prognosis on where power production will be located and the detailed characteristic of production patterns etc. Hence, a necessary step before making a decision about how the grid is going to look like is to estimate exact the location of the new investments.

5.4 Labour markets

The European Renewable Energy Council (2008) estimates that the 2020-target could increase the employment in the RES sectors by just above 2 million in EU by 2020[17]. The 2010 target is just over 1 million and consequently, it estimates that 1 million jobs will be created in reaching 2020 targets. Renewable energy creates employment at higher rates than many other energy technologies – there is labour involved in production, installation and maintenance. In fact, many of these jobs will be in the 'indirectly contributing category'. For example, manufacturing of components and

[17] The estimate includes both direct and indirect employment and is counted as full time employment.

turbines accounts for as much as 59% of the current jobs in the wind sector, for instance. The estimate is for full-time employment and includes direct and indirect employment as well as the negative impact of the jobs lost in the conventional energy sector.

Over half of the estimated total amount of new jobs in the EU in 2020 would be located in the biomass (528 000) and biofuel (614 000) sectors whereas the share of wind industry would be 318 000 and hydro 28 000. The rest is expected to come from more developing technologies such as photovoltaic (245 000) and solar thermal (280 000). It is worth noting that a large part of the employment in the biomass and bio fuel sectors is related to fuel production/use whereas in wind and solar technologies the majority of the employment impact comes in the investment phase (EmployRES report 2009).

Denmark, Sweden and Finland all have amongst the highest levels of employment in the RES sectors today, at 2,2%, 1,3% and 2,0% respectively, according to the 2009 Employ-RES report. In the future, the Nordic region is likely to see the greatest effect on employment in the wind industry.

Some more specific numbers for Sweden have been proposed recently in a report by the Federation of Swedish Farmers and the Swedish Society for Nature Conservation. Based on assumptions of a marginal renewable energy input of 70 TWh and a 20% energy efficiency effort (targets argued for in a previous report by the same organizations), the report concludes that more than 60 000 jobs could be created. Specifically, the report suggests that a 38 TWh push in bioenergy would bring about 21 000 – 25 000 jobs, a 28 TWh increase in wind power would result in 14 000 – 18 000 jobs, and that 4 TWh of extra solar capacity would provide 5 000 – 10 000 new jobs.

Following on from this, it seems natural to investigate potential job creation in the wind industry, which is largely determined by production volume. According to Jacobsen (2004) the employment effect for installing a new wind turbine is between 2 to 9 employees per MW leading to an average of 6 employees per MW[18]. The operation and maintenance of the installation has an effect of 0.1-0.45 employees per MW and average of 0.28 employees per MW. The values are the effects that follow directly[19] from new capacity building. The building stage of new plant is clearly the important part from the employment point of view. As such, one can expect an employment effect of 6 employees per installed MW for the wind industry in the Nordic region moving towards 2020. On the other hand, European Wind Energy association estimates much higher figures: 15.1 jobs/MW (See Table 6). This numbers are calculated mostly for onshore wind power plants. However, there can be higher employment effect in the case of operating, installing and maintaining offshore wind turbines. It can also support services such a vessel construction and transportation, other logistics and remote devices.

[18] The employment effects have been calculated using the input-output methodology. For further information, please see reference.

[19] Direct effect relates to employment with wind turbine manufacturing companies and sub-contractors whose main activity is to supply components related to wind turbines (Jacobsen, 2004).

Table 6. Employment effects of wind power.

Employment/MW (2007)	Jobs/ Annual MW	Jobs/Cumulative MW	Basis
WT Manufacturing – Direct	7.5	0	Annual
WT manufacturing –Indirect	5.0	0	Annual
Installation	1.2	0	Annual
Operation and maintenance	0	0.33	Cumulative
Other direct employment*	1.3	0.07	75% Annual/ 25%Cumulative
Total employment	15.1	0.4	

**IPP/utilities, consultants, research institutions, universities, financial services and other. Source: The European wind energy association 2009, Wind at Work*

On top of wind capacity, increasing utilisation of biomass is expected to have a notable impact on labour. If no new capacity for utilisation is required the biggest impact will be from fuel production. If new capacity again is needed, as was for example estimated for the second half of Sweden's biomass potential, the building phase would naturally have a significant impact on employment. For other technologies, the evaluation of labour impact would require more thorough analysis before conclusions can be drawn.

The labour market effect on the Nordic countries following the surge in RES is unclear. As illustrated by EREC's estimates, RES will create jobs even when job losses in the conventional energy space are subtracted. According to Pfaffenberger et al (2006) however, the positive labour effect in the RES sector is from some parts decreased due to job reduction in other sectors that follows from the displacement of financial resources. Adding to this that all three Nordic EU members already have high proportional employment in the RES sector, the net effect is not immediately visible. Overall, increasing the share of RES is not a macro-economic job machine, but it is clear that a notable positive labour increase in relevant sectors can be expected.

6. Conclusions and recommendations

By and large, there is not yet information how much the EU Member States will rely on RES Flex-Mex in reaching their national RES targets' or which countries will be actively hosting joint projects or exceeding their national targets and selling renewable production through statistical transfer.

By definition, utilising larger renewable energy potential and using flexible mechanism increases cost-efficiency of reaching targets. However, renewable energy has also other values than reaching targets – they improve security of supply and create new jobs. A balance between other objectives of renewable energy consumption and targets has to be found.

We recommend that the Nordic (and other) countries will carefully explore how the flexible mechanisms could complement or even supplement the domestic actions. This could be done for example through a testing ground project. The objectives of the project could be:

- *Capacity building (buyer country authorities, companies, project developers, host country authorities)*
- *Develop methods, procedures and guidelines for the utilization of the RES Flex-Mex*
- *To collaborate in addressing administrative and financial barriers*
- *To test transactions through the RES Flex-Mex mechanisms and gain valuable experience*

Based on the experiences from the carbon markets one can conclude that flexible mechanisms can be implemented. A well defined and predictable scheme can lead to increased financing in RES projects and moreover, contribute in reaching the political target cost-efficiently. However, the implementation has to be done carefully and the administration of the schemes has to be as straightforward as possible. Countries that are keen on hosting projects should establish very clear rules and guidelines for how to implement projects. Moreover, the investment environment should be stable in order to attract foreign investments.

We recommend that countries that potentially could host projects, should establish clear rules for project developers and potential buyers how to invest in the projects. Possibilities to establish selling programmes can be considered as one option.

Countries planning to purchase renewable energy value through statistical transfer, joint projects or joint projects with third countries are encouraged to rely on frameworks tested in the carbon markets. A purchase pool or programme can organise tenders or similar mechanisms to find suitable projects to be contracted. Moreover, countries can co-operate in these programmes and join forces in order to increase the purchase budget and obtain economies of scale.

We recommend that those Nordic countries that will rely on purchasing renewable energy through flexible mechanisms will join forces and establish a common purchase pool, programme or fund.

Nordic co-operation in the renewable energy policies and markets has many benefits. Currently Norway and Sweden are negotiating a common electricity certificate system which undoubtedly will impact the neighbouring countries. By and large, this common scheme has a potential to be the first joint support scheme in the whole EU. Not only it would be one of the first joint support schemes but it would also be a scheme between a EU Member State and a EEA country.

Ambitious RES targets create many challenges. From power market point of view there is an increasing need for balancing power as the wind power capacity is likely to increase significantly. In addition, increasing the import of electricity from distant sources, e.g. where the wind conditions are more favourable, will increase the need for reserve power.

We recommend that the Nordic countries continue close co-operation in energy issues and include the renewable energy flexible mechanism on this agenda. In near-term there are many possibilities for information sharing, common capacity building and other co-operation in this field. It is likely that after 2020 RES targets will increase and the need for cost-efficiency through flexible mechanism will increase as well. The Nordic countries have the opportunity and good foundations to become early movers in utilising the flexible mechanisms and in creating the framework.

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Annex 1. Joint Implementation Cycle Documents (Track 2)

Documents	Content and purpose of the document	Participants in the document
PIN **(Project Idea Note)**	Means a preliminary description of a project stating all its most relevant features (The preparation of a PIN is optional, and project developers may choose to develop a PDD directly.).	Project developer.
PDD **(Project Design Document)**	Means the project design document or business plan in relation to, or description of, the project to be submitted for Determination in accordance with the International Rules.	Project developer shall be responsible for the preparation of PDD, unless otherwise agreed by the project developer and third party that the third party is responsible for preparation.
	PDD includes Baseline Study, estimation of emission reductions and a Monitoring and Verification plan.	Project participants i.e. project developer and buyer or other parties, who participates the development of the project, shall be noted at the PDD.
	The prepared PDD shall be submitted to the Accredited Independent Entity (AIE) for Determination. Accredited Independent Entity (AIE) publishes the PDD for comments. (Determination means the process of independent evaluation of the project by an Accredited Independent Entity against the requirements of JI in accordance with the International Rules).	Accredited Independent Entity (AIE).
Baseline Study	Means a written report of the Baseline prepared as part of the Project Design Document (PDD).	Project developer/project participants Project developer unless otherwise agreed by the project developer and third party that the third party is responsible for preparation.
Monitoring Plan	Means the set of requirements for Monitoring to be included in the PDD pursuant to paragraph 4 of Appendix B to the Annex of Decision 9/CMP.1.	Project developer/project participants Accredited Independent Entity (AIE)
Draft Determination Report	Opinion of project's eligibility under JI drafted by Accredited Independent Entity (AIE).	Accredited Independent Entity (AIE)

	Draft determination report is submitted to host country as part of application for a Letter of Approval (many countries require a draft determination report before a Letter of Approval can be issued).	
Letter of Approval	Means the letter issued by the Host Country stating, *inter alia*, that the Host Country recognizes the Project for the purposes of Article 6 of the Kyoto Protocol and authorizes the parties involved to participate in the project.	Host Country authority.
	Approvals are confirmed by the accredited independent entity (AIE) as part of the project Determination. The Accredited Independent Entity shall determine whether the project has been approved by the parties involved (9/CMP.1, Annex, paragraph 33(a)).	The Accredited Independent Entity (AIE).
Determination Report	Means a written report prepared by an Accredited Independent Entity of the Determination.	Accredited Independent Entity (AIE) determines that the project meets the requirements of the JI guidelines and makes its Determination publicly available.
	Accredited Independent Entity (AIE) submits determination report and host country approval to secretariat, the report will be made publicly available. Two JISC members, advised by two experts, appraise the Determination Report.	Two JISC members, advised by two experts.
Monitoring Report	The JI rules require project participants to submit to the AIE a monitoring report in accordance with the monitoring plan on the emission reductions achieved by the project. This report is to be made publicly available by AIE.	Project participants. Accredited Independent Entity (AIE).
Initial Verification Report	Means a report of the project to ensure all Monitoring Plan-mandated data collection and management systems are in place to allow subsequent successful Verification of the GHG reductions. AIE verifies the emission removals achieved by the project upon receipt of the monitoring report from project participants, provided that the emission reductions were monitored and calculated in accordance with the rules.	The Accredited Independent Entity.

	AIE will submit an Initial Verification Report to the secretariat, and it will be made publicly available. Upon submission of Initial Verification Report for publication, the written approval of another country (Declaration of Approval) i.e. not the host country Approval (Letter of Approval) is also required.	
Declaration of Approval	Means the letter or other document issued by the relevant national approving authority of the Annex B Country in whose registry the delivery account is established, such letter or other document approving, *inter alia*, the project for the purposes of Article 6 of the Kyoto Protocol and authorizing the delivery account holder/parties involved to be a project participant with respect to the project.	National authority of the "investor country"
Verification Report	Means a written report prepared by the Accredited Independent Entity of the verification which independently assesses the amount of GHG reductions generated by the project during the preceding verification period. The Accredited Independent Entity (AIE) verifies the emission reductions or removals set out in the report and makes its Verification Report publicly available. Two JISC members appraise the Verification Report.	The Accredited Independent Entity (AIE). Two JISC members.
Modalities of Communication	All communications between project participants and the Joint Implementation Supervisory Committee (JISC) (except for communications made through the accredited independent entity (AIE) engaged to determine the project or verify its emission reductions or removals) must be made in accordance with the *Modalities of communication of project participants with the Joint Implementation Supervisory Committee*	Project participants and JISC

Annex 2. Technical potentials of new RES-E production

Country	Technology	Potential in TWh	Source
Denmark	Onshore wind	2.76	Elforsk rapport 08:17 "Vindkraft i framtiden"
Denmark	Offshore wind	9.38	
Denmark	General biomass	4.01	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.
Denmark	Biogas	1.65	
Denmark	Recyled material	0.3	
Denmark	Photovoltic	0.5	
Denmark	Wave	0.1	
Finland	Onshore wind	1.83	Elforsk rapport 08:17 "Vindkraft i framtiden"
Finland	Offshore wind	4.27	
Finland	Forest biomass	2.7	Energiateollisuus, 2007. Selvitys uusiutuvan energian lisäämisen kustannuksista ja edistämiskeinoista
Finland	Straw	0.9	
Finland	Reed canary grass	0.6	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.
Finland	Biogas	0.8	
Finland	Recyled material	1.3	
Finland	Large hydro	1.33	
Finland	Photovoltic	0.1	
Norway	Small hydro	18	Blåfall AS, Lysakertorg 8,1366 Lysaker Norway
Norway	Large hydro	3	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.
Norway	General biomass	0.5	NVE-report 01-2004, Elproduksjon basert på biobrensler
Norway	Tidal	1	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.
Norway	Onshore wind	17.4	ENOVA. 2008. Mulighetsstudie for landbasert vindkraft 2015 og 2025.
Norway	Offshore wind	59.57	Elforsk rapport 08:17 "Vindkraft i framtiden"
Norway	Osmotic	12	Skilhagen S E, et al. 2008.
Norway	Wave	12	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable

			electricity in Europe Feb. 2006.
Sweden	Onshore wind	20	Elforsk rapport 08:17 "Vindkraft i framtiden"
Sweden	Offshore wind	10	
Sweden	Biogas	0.7	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.
Sweden	Recyled material	1.08	
Sweden	Large hydro	3	
Sweden	Small hydro	2	
Sweden	General biomass	8.49	
Sweden	Forest biomass	9	
Sweden	Photovoltic	1.5	

Annex 3. Model assumptions

Exogenous variable	Value	Comment
Technical potentials	Annex 2	-
CAPEX, OPEX	Annex 3	-
WACC	10 %	Reflects a typical required rate of return from investing in the energy sector
Investment life time	20 years	-
Depreciation	5% per year	.
Income tax	28% in Denmark, Norway and Sweden, 26% in Finland	-
Inflation	2% per year from and including 2009, previous years based on Eurostat's Harmonized Consumer Prices Index	Inflation affects CAPEX, OPEX and the subsidised price of electricity
Full load hours	Annex 3	-
Grid cost	None	The sensitivity of the results to transmission costs is analysed in Section 4.3.5

Annex 4. CAPEX and OPEX estimates of new RES-E investments

Low/ high point	Country	Technology	CAPEX in 2009 in EUR per MW	OPEX in 2009 in EUR per MWh p.a.	Full load hours per year	Source for CAPEX	Source for OPEX
Low	Denmark	Onshore wind	1,356,600	43,804	1927.2	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.	
High	Denmark	Onshore wind	1,464,720	43,804	1927.2		
Low	Denmark	Offshore wind	1,681,980	71,182	2978.4		
High	Denmark	Offshore wind	1,953,300	71,182	2978.4		
Low	Denmark	General biomass	602,307	60,231	2628		
High	Denmark	General biomass	4,599,434	180,692	2628		
Low	Denmark	Biogas	1,642,655	60,231	2628		
High	Denmark	Biogas	4,927,965	191,643	2628		
Low	Denmark	Recyled material	4,708,944	98,559	2628		
High	Denmark	Recyled material	6,712,983	98,559	2628		
Low	Denmark	Photovoltic	5,563,124	41,614	2628		
High	Denmark	Photovoltic	6,493,962	51,470	2628		
Low	Denmark	Wave	2,409,227	48,185	2190		
High	Denmark	Wave	3,066,289	58,040	2190		
Low	Finland	Onshore wind	1,356,600	43,629	2628	Pöyry Energy Oy. Tuulivoimatavoitteiden toteutumisnäkymät Suomessa - Päivitetty tilannekatsaus 2007.	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.
High	Finland	Onshore wind	1,464,720	43,629	2628		
Low	Finland	Offshore wind	1,681,980	70,898	2978.4		
High	Finland	Offshore wind	1,953,300	70,898	2978.4		
Low	Finland	Forest biomass	0	0	2628	Pöyry Energy Oy. 2007. Puupolttoaineiden kysyntä ja tarjonta Suomessa vuonna 2020 - Päivitetty tilannekatsaus.	
High	Finland	Forest biomass	0	0	2628	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.	
Low	Finland	Straw	0	0	2628		
High	Finland	Straw	0	0	2628		
Low	Finland	Reed canary grass	0	0	2628	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.	
High	Finland	Reed canary grass	0	0	2628		
Low	Finland	Biogas	2,170,561	59,990	2628	Biokaasulla tuotettavan sähkön syöttötariffi Suomessa - Perusteita järjestelmän toteuttamiselle.2007.	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.
High	Finland	Biogas	4,908,303	158,156	2628		
Low	Finland	Recyled material	4,690,156	98,166	2628	Uusiutuvan energian	OPTRES Report(D4) of

Low/ high point	Country	Technology	CAPEX in 2009 in EUR per MW	OPEX in 2009 in EUR per MWh p.a.	Full load hours per year	Source for CAPEX	Source for OPEX
High	Finland	Recyled material	6,686,200	98,166	2628	lisäysmahdollisuudet vuoteen 2015. 2005	the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.
Low	Finland	Large hydro	872,587	38,176	4380	Energiateollisuus, 2008	
High	Finland	Large hydro	3,926,643	38,176	4380		
Low	Finland	Photovoltic	5,540,929	41,448	2628	Uusiutuvan energian lisäysmahdollisuudet vuoteen 2015. 2005	
High	Finland	Photovoltic	6,468,053	51,265	2628		
Low	Norway	Small hydro	893,520	43,545	3504	NVE-report small hydro potential 2004	
High	Norway	Small hydro	2,233,800	43,545	3504		
Low	Norway	Large hydro	870,891	59,874	4380	NVE-report 05-2005 "Kraftbalansen mot 2020"	
High	Norway	Large hydro	3,919,012	38,102	4380		
Low	Norway	General biomass	277,341	87,089	2628	NVE-report 01-2004, Elproduksjon basert på biobrensler	
High	Norway	General biomass	2,244,140	87,089	2628		
Low	Norway	Tidal	2,906,600	47,899	2190	Sweko Grøner for ENOVA SF 2007 "Potensialstudie av havenergi i Norge"	
High	Norway	Tidal	2,906,600	47,899	2190		
Low	Norway	Onshore wind	1,368,167	48,508	3000	ENOVA. 2008. Mulighetsstudie for landbasert vindkraft 2015 og 2025.	
High	Norway	Onshore wind	1,865,682	48,508	3000		
Low	Norway	Offshore wind	1,681,980	70,760	2978.4	NVE-report 9-2008 "Vindkraftpotensialet utenfor norskekysten."	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.
High	Norway	Offshore wind	1,953,300	70,760	2978.4		
Low	Norway	Osmotic	5,987,379	74,026	6920.4	Statkraft 02-2006 "Osmotic Power - A huge renewable energy source"	Skilhagen S E, et al. 2008 and OPTRES
High	Norway	Osmotic	6,531,686	74,026	6920.4		
Low	Norway	Wave	3,102,551	57,697	1752	Sweko Grøner for ENOVA SF 2007 "Potensialstudie av havenergi i Norge"	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.
High	Norway	Wave	3,102,551	57,697	1752		
Low	Sweden	Onshore wind	1,356,600	43,506	2628	Elforsk rapport 08:17 "Vindkraft i framtiden"	
High	Sweden	Onshore wind	1,464,720	43,506	2628		
Low	Sweden	Offshore wind	1,681,980	70,697	2978.4		
High	Sweden	Offshore wind	1,953,300	70,697	2978.4		
Low	Sweden	Biogas	1,631,469	59,821	2628	Värmeforsk 2006	
High	Sweden	Biogas	4,894,406	190,338	2628		
Low	Sweden	Recyled material	4,676,877	97,888	2628	Profu, 2007	
High	Sweden	Recyled material	6,667,269	97,888	2628		
Low	Sweden	Large hydro	870,117	38,068	4380	Energimyndigheten ER 2007-20 "Tilgång på förnybar energi"	
High	Sweden	Large hydro	3,915,525	38,068	4380		
Low	Sweden	Small hydro	870,117	43,506	3504		
High	Sweden	Small hydro	1,740,233	43,506	3504		
Low	Sweden	General biomass	1,087,646	87,012	2628	OPTRES Report(D4) of the IEE project: Potentials and cost for renewable electricity in Europe Feb. 2006.	
Low	Sweden	General biomass	2,610,350	179,462	2628		