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Nordic view on EU energy efficiency targets
Nordic view on the next generation of EU energy efficiency targets

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Nordic views on the next generation of EU energy efficiency targets

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Norræna ráðherranefndin styrkti útgáfu skýrslunnar. Efni skýrslunnar endurspeglar þó ekki endilega sjónarmið, stefnu eða meðmæli Norrænu ráðherranefndarinnar.

Finsk

Pohjoismaiden ministerineuvosto on myöntänyt tukea raportin julkaisemiseen. Raportin sisältö ei välttämättä edusta Pohjoismaiden ministerineuvoston kantaa, näkemyksiä tai suosituksia.

Færøsk

Henda frágreiðing er útgivin við fíggjarligum stuðli frá Norðurlendska ráðharraráðnum. Innihaldið í frágreiðingini endurspeglar kortini ikki við vissi sjónarmið, meiningar, hugburð og tilmæli hjá Norðurlendska ráðharraráðnum.

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Abbreviations

Carbon – CO_2 equivalent (energy related emissions)
CHP – Combined heat and power
EE – Energy efficiency
EEA – European Economic Area
ETS – Emissions trading scheme
GDP – Gross domestic product
GHG – Greenhouse gasses
M – Million
MCEE – Marginal cost of energy efficiency
MS – Member state (of the European Union)
NEEAP – National energy efficiency action plan
RD&D – Research, development and demonstration
RE – Renewable energy

Definitions

Final energy consumption – The energy delivered to final end-users, excluding distribution network losses and excluding deliveries to and use of energy in the energy sector.

Primary energy consumption – Energy production including net import, net change in stock and recovered products but excluding fuel to maritime bunkers. Primary energy consumption is by Eurostat termed 'gross inland consumption of primary energy'.

1 Executive summary

EU has a target for energy efficiency for 2020, namely a 20 % reduction in the primary energy consumption relative to the PRIMES 2007 forecast for 2020. According to the new energy efficiency directive, that was agreed upon in June 2012, the target is that primary energy consumption must be no more than 1,474 Mtoe or that final energy consumption must be no more than 1,078 Mtoe by 2020. This is an absolute target for EU as a whole. There are no binding targets for member states.

Due to the time lapse from goal setting, to policy formulation and practical implementation it is found that 2020 *is just around the corner,* and that it is high time to start discussion about the next goals. This could be concrete targets for 2030 and indicative targets for 2050. In this report target design and policy instruments are discussed from a Nordic perspective: Is it relevant to have an energy efficiency target? Should targets for energy efficiency be set in terms of *primary* energy or *final* energy? In *absolute* numbers or in *relative* numbers? Whether and how to divide the burden sharing? What are the Nordic positions of strength with regard to policy instruments?

1.1 Nordic energy consumption 2030

As a basis for discussing energy efficiency targets for 2030 a simplified model has been set up. The model illustrates the energy consumption in the Nordic region in 2030 in a reference case (frozen policy that includes decided policies and measures that will be implemented in the coming years) and with six alternatives with different energy efficiency policy instruments activated: 1) Increased share of CHP, 2) improved building insulation, 3) increased efficiency of lighting and other electric appliances, 4) increased boiler and heat pump efficiency, 5) increased use of heat pumps, and 6) more wind power. All results are presented in both primary energy and final energy – and compared to four targets for 2030 defined in absolute or relative terms, and in primary or in final energy. Parameter variation is performed with low and high economic growth.

The current energy consumption in the Nordic region is in the order of 4,900 PJ primary energy and 3,900 PJ final energy. The model indicates that with an economic growth of 1.75 % p.a. these values will be roughly unchanged in 2030. This illustrates the considerable level of energy efficiency improvement that can be expected with a continuation of current policy.

Energy consumption in 2030 depends on the economic growth, and this has consequences for how difficult it is to reach different energy efficiency targets. This is illustrated in Figure 1.

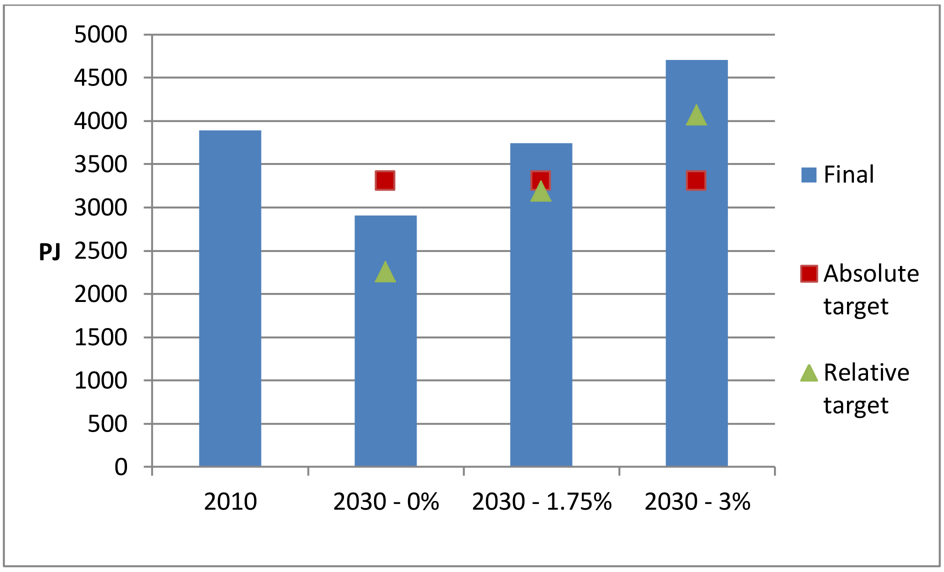

Figure 1: Final energy consumption and alternative formulation of energy efficiency targets.

The results of the model analysis also illustrate how the different policy measures have different impact on primary and final energy consumption. In some cases energy efficiency measures result in increased export of electricity. See chapter 6 for further details about results, model set-up, and assumptions.

1.2 Setting new EU targets

It is expected that the EU will set ambitious energy efficiency targets – however, the *level* of ambition is not the subject of this report.

Historically energy efficiency has been thought of as a final energy target, but defining the target in primary energy has some advantages, e.g. that member states can balance supply solutions with improvements in end-use of energy.

An advantage of expressing energy efficiency targets in final energy is that the target can be adapted to sector-specific conditions (e.g. high reductions in buildings, and less in transport). Improvements in energy efficiency in end-use consumption will also have effects on consumption of primary energy. Savings in final energy consumption can also make it possible to increase export (e.g. of electricity or biomass). Import and export is a special challenge in relation to setting national energy targets.

Important ways to increase (primary) energy efficiency is 1) cross-border integration within the EU, as this opens for optimisation on a broader scale making expensive supply-side investments unnecessary, and 2) to use the most efficient electricity generation (e.g. CHP combined with export of electricity that can replace fossil fuel condensing power generators). However, import/export issues may be difficult to manage in national energy efficiency targets.

Another dimension of target setting is whether it should be formulated in absolute or in relative terms. The EU 2020 energy efficiency target is in effect an absolute target. The main disadvantage is that in times of accelerated economic growth reaching the target could require very expensive energy efficiency measures (e.g. forced renovation of existing buildings). On the other hand, a target formulated in absolute terms might become too lenient in times of slow economic growth (see Figure 1).

The recent economic crisis has highlighted how a lower growth rate can influence development in energy consumption. With low economic growth it is easy to reach a target set in absolute terms. One option for the next set of EU energy efficiency targets could be to formulate these as a combination of absolute and relative target (based on expected growth rates) and allow for a correction if the economy develops significantly different than forecast.

Import/export challenges

Setting national energy efficiency targets may result in conflicts regarding import and export of electricity and biomass. This dilemma needs to be addressed, making it possible for member states to adjust their performances. Disadvantages occur if e.g. a member state wishes to be independent of electricity imports through investments in domestic power generation capacity. This would result in efficiency losses (in primary energy) and thus make it harder for the country to reach its target. In order to make it possible to have a shared EU target defined in primary energy, this challenge would need to be addressed.

The same challenges exist for biomass. Increased energy efficiency in domestic heat and power production based on domestic biomass resources can potentially reduce a country's consumption of renewable energy, allowing a larger share of biomass export. As biomass is likely to be a scarce resource in the EU in the future, this additional export should be accounted for positively.

Burden sharing?

The current EU 2020 energy efficiency target applies to the entire EU and is not distributed on member states – i.e. no indicative nor binding national targets are entailed. In order to achieve a real impact on member state policies a model for burden sharing can be relevant. The burden sharing can set a goal for each country based on the potential for energy efficiency, the country's carbon intensity, its share of renewable energy, its use of combined heat and power (or in more generic terms, its relation between final and primary energy consumption) as well as its expected economic growth. Burden sharing can also take into account the share of energy intensive industry operating on the global market.

EE in RE end-uses

Improvements in energy efficiency can be "blind" as to what kind of energy is reduced – also consumption of renewable energy might be reduced. Energy efficiency instruments can in some circumstances hit renewable energy sources more than non-renewable if this is not counteracted with other instruments, e.g. energy taxes. A way to solve this would be to differentiate the value of one kilowatt hour saved renewable energy from that of non-renewable energy, where the latter would be higher.

Effective policy instruments

Energy taxes, voluntary agreements, technology procurement, energy labelling, and minimum energy performance standards are successful and preferred policy instruments among the Nordic countries.

Minimum standards set a limit below which new technology and appliances cannot go. Ecodesign raises the level of energy efficiency for a growing number of technologies. With the EU wide coverage this will undoubtedly continue to influence the development of new products.

Other end-use and system efficiencies can be reached by way of other policy instruments. The public sector can assume the role of a frontrunner and create a demand for new more efficient solutions. Voluntary agreements e.g. between energy agencies and targeted actors may be used to initiate energy management systems among industrial enterprises, real estate owners, municipalities, energy companies, etc. Energy taxes are the most generic instrument and allow for a good deal of freedom among targeted actors. Taxes are typically preferred when there is no need to discriminate between different technologies.

1.3 Recommendations

EU has a target for energy efficiency for 2020. This has been re-confirmed in relation to the new Energy Efficiency Directive that was decided in June 2012.

This project study the challenges and possibilities in relation to setting new long term targets for energy efficiency.

Based on the analyses, it is suggested that the Nordic Council of Ministers recommends that EU starts a process with the aim of formulating EU-wide targets for energy efficiency for 2030.

Furthermore, the analyses found:

- It is relevant for the EU to have an energy efficiency target to complement other targets on, e.g. CO_2 and renewable energy. The potential for realising economically attractive energy efficiency projects (no-regret options) as well as achieving a positive impact on security of supply supports the idea of having a separate target for energy efficiency.
- Since it takes time to develop well-designed policy instruments, it is due time to discuss targets for 2030.
- An EU energy efficiency target is important to guide the development of policy instruments at both EU and member state level.
- The most effective approach to energy efficiency is a combination of EU policy instruments and national policy instruments to complement these – a so-called 'balanced approach'. Some end-uses and technologies are best addressed with uniform EU-wide policy instruments (such as the Ecodesign Directive and minimum taxes) to ensure a significant effect on the technology development and less technology distortion between the member states. In other domains a prerequisite for success is policy instruments adjusted to the national context of the individual member state.
- The current 2020 target for energy efficiency is formulated as an absolute target in both primary and final energy. It is found that the next generation of targets may need to be more advanced. First of all, the impact of changes in economic development is very strong in relation to an absolute target. The EU could consider mechanisms to adjust targets for conditions with unexpected economic growth as well as economic recession.
- If an EU energy efficiency target is distributed on member states a number of challenges must be solved:
  - A mechanism should be developed so that import and export of electricity and biomass among member states are encouraged and not hindered by national energy efficiency targets.

- The burden sharing must be formalised and take into account the characteristics of the individual member state with regard to the potential for energy efficiency, the country's carbon intensity, the share of renewable energy, the use of combined heat and power (its relation between final and primary energy consumption) as well as the expected economic growth. Burden sharing may also take into account the share of energy intensive industry operating on the global market.

2 Introduction and background

`A Nordic view on EU Energy Efficiency targets´ is a project for the Nordic Council of Ministers Working Group for Energy Efficiency (AGEE). *"The main purpose of the Working Group for Energy Efficiency is to promote Nordic co-operation in connection with various energy efficiency initiatives in the community as well as to promote Nordic co-operation with regard to the implementation of EU/EEA directives and programmes"* (www.norden.org).

Energy efficiency 2030

The aim of the project is to analyse the consequences of an energy efficiency target for 2030 at the EU level, seen from a Nordic perspective, and to identify areas of possible the Nordic cooperation, to serve as input to the Nordic ministers' meeting in October 2012. The project includes analyses of different target formulations for 2030 and of the consequences of a 2030 target for different sectors.

A workshop was held in May 2012 as part of the project, involving key stakeholders from Nordic and Baltic countries. The discussions and recommendations from the workshop served as an important contribution to the project analyses.

Robust development paths

A key objective within the project is to see the challenges and desired development path from a Nordic and Baltic perspective. Approaching the problem from a cross-national perspective instead of a national perspective makes it possible to develop robust recommendations for the EU level, taking into account the specific national contexts, and thus giving the Nordic and Baltic countries a stronger voice in EU energy policy.

The differences in available energy resources and energy policy approach in the Nordic and Baltic countries can be seen as a miniature of the broader European diversity regarding energy (see also chapter 4), albeit with a higher share of renewables (see Figure 2).

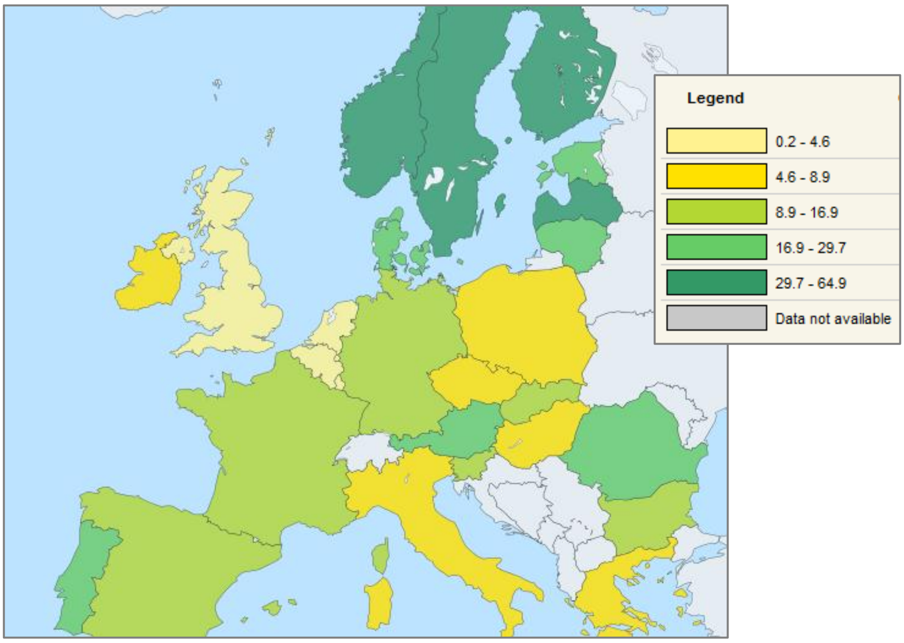

Figure 2: Share of renewable energy in final energy consumption in 2009 (Odyssee (2012)).

Defining EE

An important issue when discussing energy efficiency policy instruments is to define which elements of the energy chain are to be included. Some include efficiency measures in energy production plants and measures in the transmission and distribution system, while others limit the scope to only cover measures targeting final energy consumption. The choice of delimitation has an impact on the formulation of targets and in the choice of policy instruments for which reason it is important to understand the different national approaches to energy efficiency.

Energy efficiency is often s cost-effective means to reach overall goals of climate mitigation, energy security and competitiveness, yet the full potential is often not realised due to a number of barriers. Setting common targets and/or defining common policy instruments can be an important tool to overcome some of the barriers. Furthermore, choosing the most efficient policy instruments can be a challenge, and the individual EU member states might benefit from addressing some of these jointly at EU level. In part by ensuring that all contribute on a level playing field and in part because the impact due to for example scale effects may be expected to be greater and the overall cost lower.[1]

These and other discussion points are addressed in this report. The key discussion points are shown in Figure 3.

[1] EU (2010a). The principle of subsidiarity of the EU Treaty, article 5.

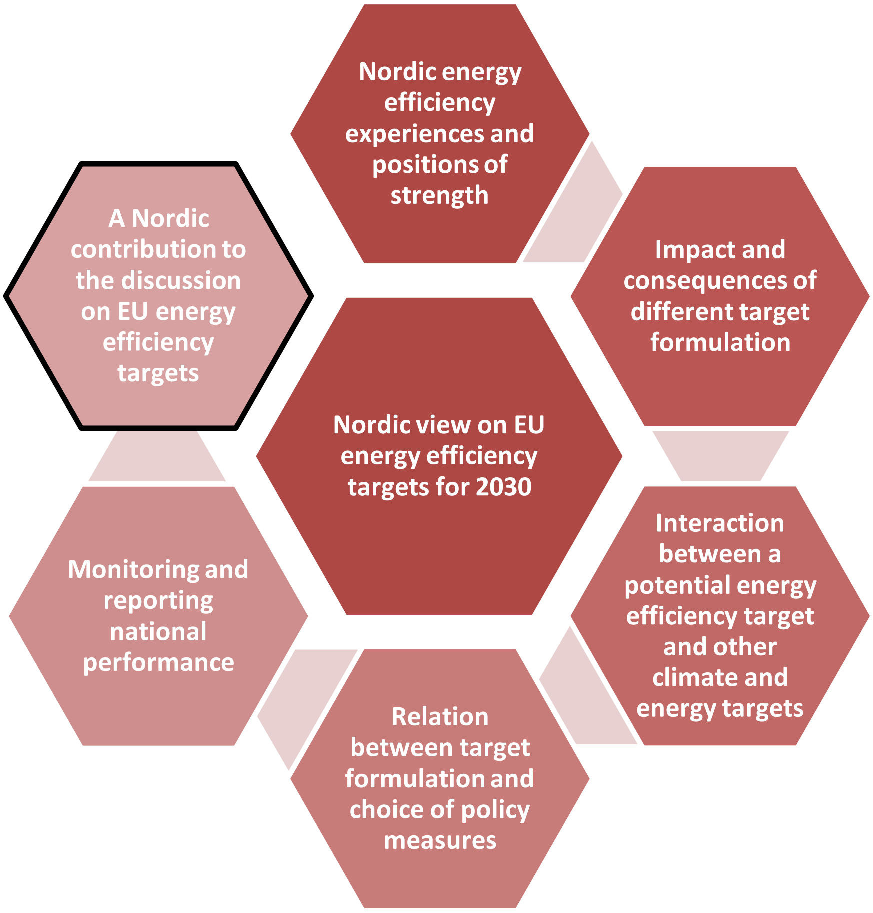

Figure 3: Key discussion points.

Framework takes time

Setting targets and defining policy instruments at EU level takes time. The process of agreeing on a framework, collecting data, setting up national structures etc. is likely to take several years. In addition, the time from national implementation to achieving measurable impact can also be long, e.g. energy renovation of existing building stock. Seen from this perspective 2020 is very near, which means that the discussion on possible next targets needs to start now.

Marginal cost of energy efficiency

In some analyses the cost of the policy instruments are ignored; and only the technical costs of the projects (e.g. extra insulation) are included. Because energy efficiency is a large number of small projects, ignoring cost of policy instruments can seriously underestimate the total socio-economic costs.

In relation to the analyses of energy efficiency it can thus be relevant to define the marginal cost of energy efficiency (MCEE). MCEE is the total cost for energy efficiency per additional unit of energy saved due to the instrument. The total cost includes end-user investment as well as the cost of the applied policy instruments to promote energy efficiency.

For well-designed policy instruments MCEE can be below the price of energy i.e. negative. Such can be found to the left in marginal abatement cost curves (see e.g. Figure 5). The existence of negative costs cannot be explained by "rational" behaviour, but by phenomena beyond the reach of the neoclassical price mechanism. Suggested explanations are associated with 'split incentives', 'principal-agent problems' or 'information asymmetries'.[2]

On the other hand, examples of less successful instruments also exist: The Danish building labelling scheme was analysed based on data from 1999-2002 with advanced statistical methods.[3] The conclusion was that no marginal effect could be found. The labelling required a consultant to inspect the individual building, and with minimal impact the MCEE was estimated to be many times the energy price.

Assuming that the policy instruments are designed so that the cheapest energy efficiency improvements are realised first, the MCEE can be expected to increase with the ambition level of the reduction targets. Thus, countries with a long tradition of working with energy efficiency can expect the remaining energy efficiency options to have higher MCEE.

However, it is difficult to predict the effects on energy use for each measure as energy efficiency measures are often context specific: Each industry and each building is unique, which means that the same energy efficiency measure will give different results. Also end-user behaviour can interfere with expected results (for example the habit of airing rooms with open windows for several hours can outdo gains from energy efficiency measures). Designing efficient policy instruments is thus a challenging task. Nevertheless, estimates have been made in Denmark. Table 1 shows key economic figures from a recent evaluation of the Danish energy efficiency obligation scheme. The scheme is attractive for service and industry, but for households the end-user costs are so high that the value of energy savings does not offset the total costs.

[2] Sorrell, Steve et al (2000), IEA (2007)
[3] Kjærbye, H. V (2008)

	Unit	Households	Service and industry
Costs for utilities	M€	26	85
Costs for end users	M€	118	83
Total cost[4]	M€	136	142
Value of additional savings	M€	43	315
Balance	**M€**	**-94**	**173**
Specific costs	€/kWh	0.31	0.04
Reference energy price	€/kWh	0.10	0.10

Table 1: Key economic figures from an evaluation of the Danish energy efficiency obligation scheme. Adding utility and end-user cost and comparing these with the value of the additional savings indicates that the social economy is positive only for service and industry.(Ea Energy Analyses et al, 2012).

Awareness through NEEAPs

Another argument for starting the target discussion already is that earlier experiences have shown how planning and discussion of energy efficiency targets and policy instruments in themselves promote activities and awareness, and can create spill-over effects. This has been the case with the development of National Energy Efficiency Action Plans (NEEAPs) required by EU legislation. At the project workshop in May 2012 several participants pointed out how the development of a NEEAP proved to have a value in itself, as it has brought about an awareness of national energy efficiency activities. In e.g. Finland the experience was that their NEEAPs afterwards have been useful for other purposes, and serve as a means to illustrate what has already been done.

This report is intended to help kick-start the discussions at the Nordic level.

[4] In total costs are included corrections for the use of subsidies. Subsidies are considered as a transfer cost and a cost element representing the tax disturbance are included.

3 Target formulation

Energy policy in EU and member states is driven by three types of arguments: Environment (local, regional and global), security of supply (self-dependence, balanced energy mix) and economy (economic growth, stable energy costs). This is also the case for energy efficiency policy:

"Energy efficiency is the most cost effective way to reduce emissions, improve energy security and competitiveness, make energy consumption more affordable for consumers as well as create employment, including in export industries."[5]

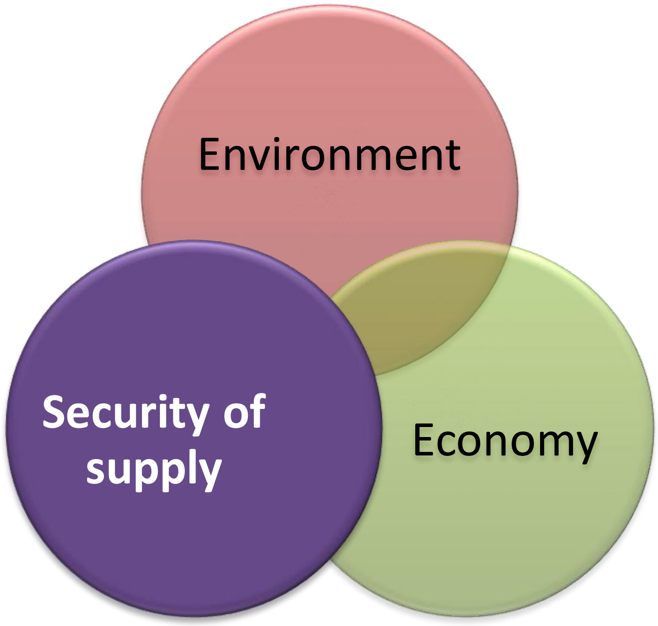

Figure 4: Energy policy balances three interests: Environmental protection, security of supply, and economic growth.

3.1 Why is energy efficiency targets needed?

This must be seen against the background of the primary instrument for combating climate change that the EU has implemented – its CO_2 emissions trading scheme (EU ETS). A market has been created in which emitters have a choice to buy or sell emission rights and count investments in countries outside the scheme as fulfilments of obligations. The intention is to internalise climate change costs through a steadily declining quota of emission rights leading to higher costs for the use of fossil fuels.

[5] COM (2010) 639, *Energy 2020.*

Unsuccessful global negotiations

In order for greenhouse gas (GHG) emission abatement to be effective in reaching the target of maximum 2° Celsius above the preindustrial average[6] some costly investments are needed. A reduction at about 35 Gt carbon per year is estimated to be necessary, according to a global cost curve for abatement costs (see Figure 5), thus leading to a price at about 40 €/t carbon.[7]

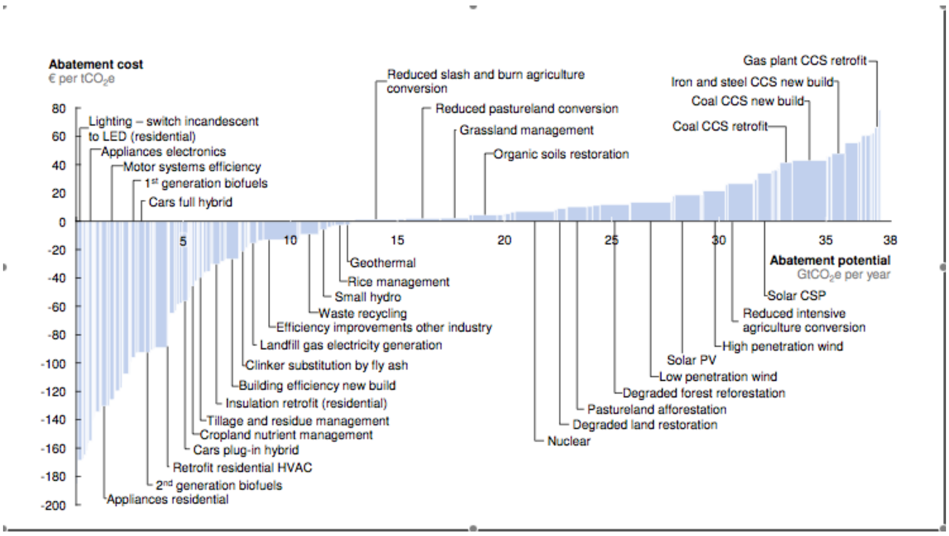

Figure 5: Greenhouse gas abatement cost curve McKinsey (2010).

However, negotiations on a worldwide program for reducing emissions have not been successful beyond the EU ETS, as several big countries have been reluctant to sign an agreement. This means that until now a common instrument for global reduction of emissions has not been agreed upon. This adds importance to energy efficiency as a alternative tool for getting closer to the target.

Fear of industrial leakage

A higher price for fossil fuels within the EU has nevertheless been a threat to the competitiveness of European industries active on international markets. This potential "leakage" of fossil energy intensive industries to low cost countries has been an argument in favour of lower energy taxes for industry, but adds also to the impetus for energy efficiency policies, as this lowers costs without lowering prices, for the sake of defending European competitiveness and employment.

[6] As indicated in the negotiations organised by the United Nations.
[7] The term carbon is used for CO_2 equivalents.

Security of supply

Furthermore, energy efficiency is suitable also for other purposes. Secure supply of energy has been an important goal in many countries, accentuated by conflicts between states during the 20th century. The EU has used economic integration as the main lever for its unification, as indicated by the primary role for the EU in relation to member states concerning trade, the internal market, and the Euro. However, import of oil, gas, and electricity is not without its problems as conflicts in other parts of the world can disturb supply. Especially the Baltic states are vulnerable to dependence on imported gas and electricity as they are small, have limited natural resources and seek to avoid such geo-political disturbance as that between Ukraine and Russia 2005-2009. These problems associated with security of supply also work in favour of improvements in energy efficiency, as reduced consumption may reduce import and thus reduce vulnerability to disturbance in deliveries.

EU MS objectives

In the communication from the Commission, Energy 2020, cited earlier, energy efficiency is intended as a means to reach all the overarching objectives: Climate, competitiveness, and security of supply, with emphasis on the latter. In individual member states emphasis may vary and change over time. The oil crisis in the 1970's brought fuel security to the top of the political agenda. The situation of Norway given its national energy resources is quite different from that of e.g. Denmark. Each Nordic country is small and can only contribute to a small degree to the global problem. The EU has an important role to play as it represents 12-14 % of world-wide emissions and energy use, and has an even higher economic and political weight.[8]

Even though some improvements in energy efficiency are made spontaneously, the full potential of energy savings is not exploited. Furthermore, some member states can be in need of early implementation due to urgent problems associated with EU's commitment to stop global warming, political pressure associated with import of energy, and threats to employment associated with high relative costs for energy. Exploiting so-called 'no-regret opportunities' for energy efficiency improvements as they arise, will limit the cost of these improvements.

The beneficial interplay between overall energy policy objectives, the resilience of using a combination of energy efficiency, renewable energy and ETS targets, and the exploitation of no-regret opportunities is sought illustrated in Figure 6 below.

[8] COM(2010)639.;Sweden (2008/09);; IEA (2011).

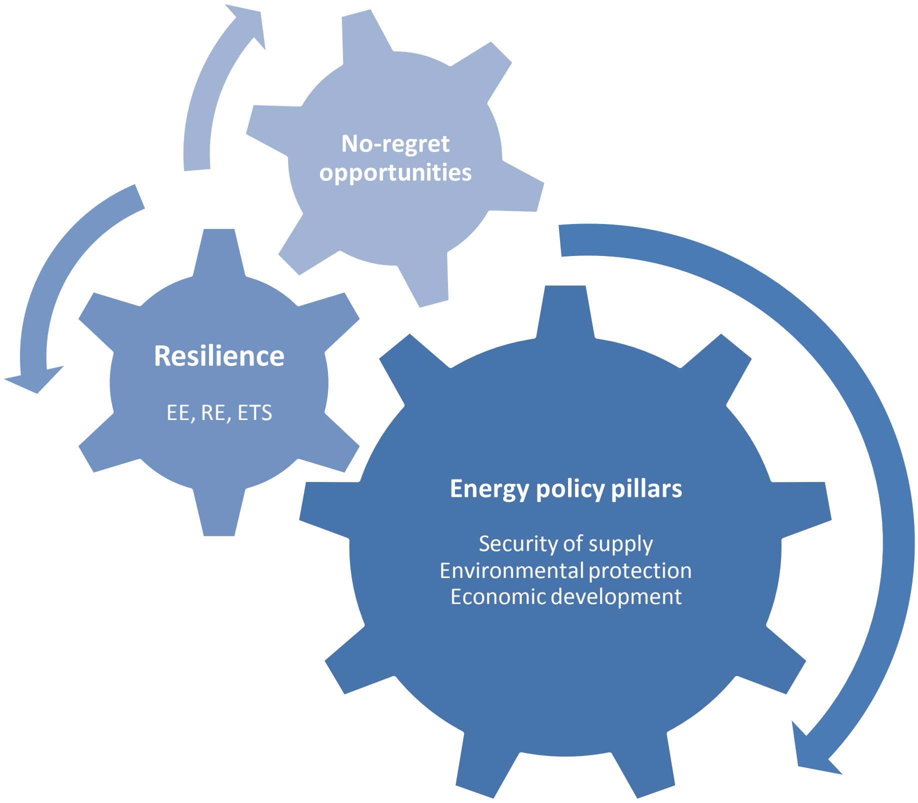

Figure 6: Several elements that come together.

3.2 Primary and final targets

Primary or final energy consumption

Targets can be formulated in terms of primary energy or in final energy, and in absolute numbers or in relative numbers. By 'primary energy' we here mean the equivalent to what Eurostat defines as 'gross inland consumption of primary energy' which includes production and imports. With 'final energy' we mean 'Final energy consumption' in Eurostat's terms, i.e. all energy delivered to the final consumer's door (in the industry, transport and other sectors).[9]

The main advantage of formulating a target in primary energy is that improvements in efficiency in energy production (but not import of electricity) are included so that savings can be promoted also in production of heat and electricity. An advantage of expressing the target in final energy is that targets can be set in more sector specific terms, i.e. sensitive to specific barriers and potentials in each field of implementation.

[9] Eurostat (2012b) (2012-05-09). "Gross inland consumption is defined as primary production plus imports, recovered products and stock change, less exports and fuel supply to maritime bunkers (for seagoing ships of all flags). It therefore reflects the energy necessary to satisfy inland consumption within the limits of national territory."

The difference between primary and final energy is transformation and network losses and use of energy in the energy sector (see Figure 7). Losses are considerable in the case of thermal (e.g. nuclear and fossil) electricity generation as only 30-40 % is turned into electricity, while for example wind, photovoltaic, and hydro plants have by definition lower or no losses. This means that when the target is set in primary energy it is easier to reach the target when thermal units are replaced with non-thermal units. But this difference disappears when the target is defined in final energy.

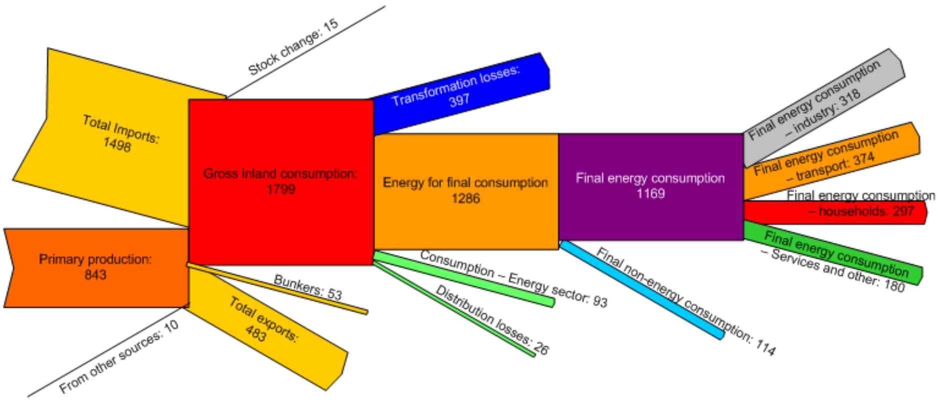

Figure 7: EU27 flow of energy 2008 (Mtoe) (Own drawing based on Eurostat).

Import and export problems

Statistically the different energy carriers are not treated in the same way. When electricity imports and exports for individual member states are considered, a final energy target is preferable. With a target expressed in primary energy consumption the transformation losses from thermal electricity generation and network losses are counted, while imported electricity is measured net of these losses. So, when a country, such as Finland, wishes to replace import of Russian nuclear electricity with electricity from domestic thermal plants, it will be punished in terms of energy efficiency when the target is set in terms of primary energy.

The differences are sought illustrated in the table below. Electricity produced on thermal plants and exported is in the counted in the national statistics of the exporting member state as primary energy consumption (=2.5 times the produced electricity) and as zero final energy consumption, while imported electricity irrespective of production plant type is given equal weight for both primary and final energy consumption in the importing country (value 1 in the table).

Energy carrier	Primary energy consumption	Conversion losses	Final energy consumption
Electricity produced on thermal plants (nuclear, fossil, renewable)	2.5	1.5	1
Electricity produced on non-thermal plants (wind, hydro, photovoltaic)	1	0	1
Export of electricity (thermal based)	2.5	1.5	0
Export of electricity (wind, hydro, photovoltaic)	1	0	0
Import of electricity – irrespective of source plant	1	0	1
Individual & collective stand-alone heat pumps – assumed driven by thermal based electricity	2.5	1.5	3-4

Table 2: Illustration of the difference in what is counted how depending on whether the energy efficiency target is measured in primary or final energy. Please note that the figures are only meant to illustrate relative differences between primary and final energy consumption for the energy carrier in question (the columns) and cannot be compared across energy carriers (the rows).

The EU promotes energy market integration, specifically for electricity and gas. Cross-border market integration and trade can increase the EU wide technical efficiency, e.g. because of the greater opportunities for raising the load factor for efficient power plants. When several areas are connected differences in consumption patterns and production facilities can supplement each other, and by way of export and import plant capacity may be used more effectively, and investment in production expansion avoided[10].

However, political concerns at member state level regarding security of supply, independently of the EU, and protection of economic sectors may temporarily override the wish for full market integration and the energy efficiency gains deriving from such integration. Relations between member states are not always perfect for cooperation and trade since it requires trust so that each country can relax demands on national self-sufficiency. An energy efficiency target defined in final energy will not influence the role for domestic production.

When the level of efficiency is raised in the final use of energy it also affects primary energy consumption, including the need for imports, so that countries with problems associated with imports of electricity and gas can reduce its risks. However, this means that the energy transformation sector is left out

[10] The interaction of the Nordic countries as one regional unit is explored in section 5.9.

from the efficiency target. So a target set in terms of final energy needs to be supplemented by other policies directed at the energy transformation sector (including network), such as promoting district heating, CHP production, or cross-border market integration. The electricity market is highly integrated among the Nordic countries and Estonia.

3.3 Absolute and relative targets

The terms 'absolute' and 'relative' refer to the option of formulating the target in terms of straight energy units (e.g. TWh), or relative to something else, for example the number of inhabitants or the level of economic activity (TWh/capita or TWh/GDP measured in deflated national currency units). 'Energy intensity' is another term for the latter.

EU 2020 target

The 2020 energy efficiency target for the EU is an example of a target in absolute numbers, specifically at 1,474 Mtoe primary energy (see Figure 8). It is based on projections on future use of energy, in specific numbers (1,842 Mtoe), and a reduction of 20 %.

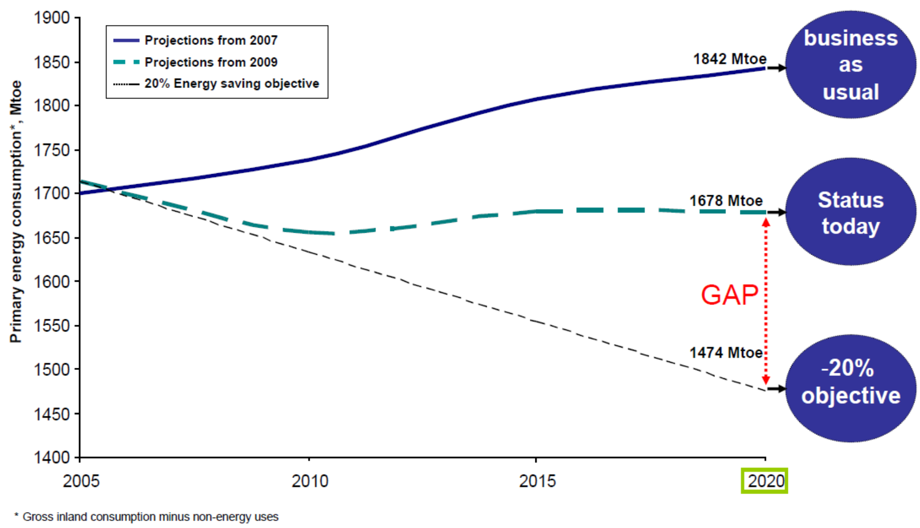

Figure 8: EU 2020 energy efficiency target (EU (2011b).

Target	Absolute/Relative	Carbon/Primary/Final
Energy efficiency +20 % 2020	Absolute	Primary
Energy efficiency +9 % 2016	Absolute	Final
Emission reduction –20 % 2020	Absolute	Carbon
Renewable energy share 20 % 2020	Relative	Gross final

Table 3: Overview of energy and climate targets.

The target for renewable energy in 2020 is a 20 % share of final energy (including network losses and electricity used in electricity and heat production). It is a relative target as it depends on the amount of energy produced from non-renewable energy sources. The target could to a certain extent be reached by energy efficiency improvements in end-use consumption of non-renewable energy.

Looking at the different sectors of the economy the choice between an absolute and a relative target has different implications. Industrial energy use is more influenced by business fluctuations than other sectors. While the residential sector is relatively stable in its energy use from year to year, international economic booms and busts create significant ups and downs in total energy use in the industry sector. The sensitivity of the transport sector and the tertiary sector lies somewhere in between as they are influenced by both households and industries.

When the energy efficiency target is set in absolute terms this creates a cap on energy use that is not sensitive to business fluctuation from year to year. An option could therefore be to set separate targets for each sector and allow for special considerations for the industrial sector.

One should also keep in mind that the possibility for changing energy carrier (e.g. from fuel oil to district heating) differs between the sectors. Since the efficiency of the various energy systems differs, so will the possibility for energy efficiency improvements related to the choice of energy carrier.

Influence of GDP on energy consumption

The intensity target is defined by two variables – energy consumption and GDP – where energy consumption to at least some degree depends on the development of GDP, although there is certainly no reason to assume a 1:1 ratio. Denmark has experienced economic growth during the last 20 years with only marginal change in primary energy and final energy consumption, while Norway and Finland have increased their consumption (see chapter 4, Figure 13 and Figure 14).

Traditionally governments prefer strong GDP growth, even if an increase in energy consumption is a consequence hereof. Growing GDP combined with an absolute target for energy efficiency would imply a need for strengthening existing energy efficiency instruments or activating additional instruments. In both cases the marginal cost of energy efficiency would increase.

An absolute target of *primary* energy savings includes efficiency improvements in transformation and network, besides improvements in end-use. This allows for a transfer of efficiency measures from end-use to the energy sector, and thus reduces the burden on end-use sectors in times of economic growth. But an absolute target in *final* energy leaves no such escape in times of economic growth and in countries with a large share of internationally active industries, and is therefore harder to accept politically. In fact, an absolute target in final energy can force industries to shut down or leave the country, and thereby creating the false impression of improved efficiency in domestic energy statistics. This is not energy efficiency from an EU point of view, but only a loss of production, income, and employment in the concerned member state.

In times of zero economic growth or even a decrease in economy, an absolute reduction target will become even easier to reach than an intensity target (because in a recession energy consumption in absolute numbers will be reduced as a result of falling industrial production, while the intensity target is relative to GDP). An intensity target would on the other hand require extra instruments to be reached.

	Relative target	Absolute target in final energy	Absolute target in primary energy
Increasing GDP	Requires extra instruments	A threat to energy intensive industries	More flexible than in final energy but a prerequisite is a big energy efficiency potential in the energy sector
Decreasing GDP	Requires extra instruments, perhaps even more than with an absolute target	Reachable even without extra instruments.	Reachable, even without extra instruments.

Table 4: Impact of short-term GDP changes on target fulfilment.

Table 4: shows policy challenges associated with fluctuations in the economy in the short run.

The relation between economic growth and targets formulated in either absolute or relative terms is illustrated in Figure 9. The illustration raises the question of whether it is possible to formulate a target that combines the two types – for example an absolute target that is adjusted based on predefined factors depending on whether the economic growth rate differs substantially from the original projection.

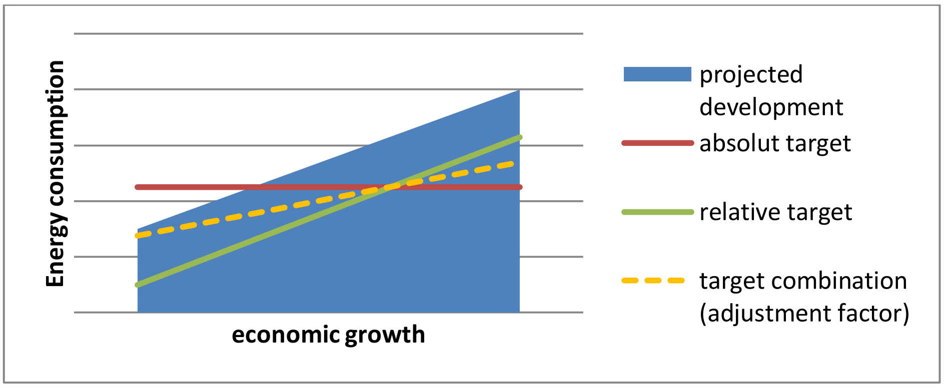

Figure 9: Illustration of the relation between economic growth and different target formulations. Please note that the inclination of the projected development (blue block) and relative target (the green line) is slightly different from one another although they appear to follow each other.

Efficiency target may conflict with the renewable target

Energy efficiency targets do not necessarily distinguish between the different types of energy. Thus, for instance, renewable energy and fossil energy are treated equally in the current EU context of energy efficiency, i.e. one kWh fossil energy saved equals one kWh renewable saved. The same applies to nuclear energy. In the EU, this is perceived to be corrected through the promotion of renewable energy through other means, such as the Renewable Energy Directive. However, the consequences of equalling fossil and renewable energy in one context while promoting the latter in another context appear not to be fully clarified.

There is broad agreement that dependence on fossil energy has to be reduced significantly. Simultaneously, renewable energy is promoted. Since renewable energy (especially biomass) should be treated as a limited resource for all practical purposes, the approach to pursue efficiency in all types of energy can be reasonable. Depending on the regulation (including taxes and subsidies) renewable energy can be more costly. In the case renewable energy is more costly there is a risk that energy efficiency measures will be directed towards renewable sources rather than non-renewable. Then additional instruments to promote renewable energy have to be implemented if the renewable target is to be reached. Thus a conflict could emerge between the promotion policies for renewable energy and overall policies for energy efficiency.

Different weights

It should therefore be further analysed how this tension could be alleviated. One option could be to give different weighting to fossil and renewable energy. For example, saving one kWh renewable energy would equal only, say, saving 2 kWh of fossil energy. By applying such weighting, incentives for energy efficiency in fossil sectors are given priority over energy efficiency in renewables, while still providing enough incentives for energy efficiency in renewables. It should be further analysed how nuclear energy can be brought into this reasoning. It should be emphasized that this weighting applies to energy efficiency considerations only.

The distinction between fossil and renewable energy is, however, not clear-cut, in particular in the electricity sector. What is e.g. the marginal fuel for a specific kWh of electricity? For this reason there is no straightforward implementation of weighting approach, but sufficiently many areas of energy use can be identified where fossil and renewable energy are separated to allow for this conjunction of energy efficiency targets and renewable targets and taking economic growth into account. District heating is one example, and fuel used by industry is another.

The major advantage of weighting approach would be that GDP growth would not automatically be hampered by an absolute target for primary energy since the extra demand for energy can be delivered by renewable energy.

Still, there are several complications to this approach. For example, setting the ratio between renewable and fossil energy right is far more complicated than indicated above. The ratio 1:2 set here is for the sake of clarity only.

3.4 Summary

Advantages and disadvantages of a target expressed in *primary* energy consumption:

- PLUS – A target in primary energy is more flexible as the energy sector is included, so that end-use can be unburdened from demands on improvements in energy efficiency, especially when combined with an absolute target and in times of GDP growth.
- PLUS – As conversion of non-renewable fuels in thermal power plants are less energy efficient than renewable, and as primary energy includes the energy sector, a target in primary energy promotes the replacement of non-renewable sources in electricity generation.
- MINUS – Member states that want to increase their security of supply by way of reducing energy imports will be punished because big transformation losses in for example nuclear production is counted gross, while imported nuclear electricity is counted net of transformation losses.

Advantages and disadvantages of a target expressed in *final* energy consumption:

- PLUS – Improvement in energy efficiency in end-use has repercussions upstream on the energy sector, and on imported energy.
- PLUS – As a target in final energy can be more sector specific and thus more sensitive to specific circumstances.
- PLUS – It eliminates the disadvantage of a target in primary energy mentioned above.
- MINUS – Improvements in the energy sector are not encouraged.

Advantages and disadvantages of a target expressed in *absolute* numbers:

- PLUS – Puts pressure on exploiting potentials for improvements in energy efficiency in general, especially in times of economic expansion.
- PLUS – It is a clear target that can be broken down into sector and sub-sector targets.
- MINUS – It is insensitive to fluctuations in GDP, especially for energy intensive industries in times of growth, but also too lenient in times of recession.

Advantages and disadvantages of a target expressed in *relative* (intensity) terms:

- PLUS – Allows for an increase in energy consumption which is especially important for energy intensive industries active in international markets.
- MINUS –There is an obvious risk that overarching goals of climate change mitigation and security of supply will be sacrificed for the sake of industrial competitiveness.

Any kind of target:

- MINUS – Energy efficiency policies do not discriminate between non-renewable and renewable energy, therefore such policies may come in conflict with the goal of increasing the share for renewable energy, especially in countries with a large share for renewable energy and in countries where renewable energy is relatively costly.

4 Profiles of the Nordic and Baltic countries

Energy consumption level

In absolute terms the Nordic countries consume significantly more energy than the three Baltic countries (Figure 10). Denmark exhibits a smaller difference between primary and final energy than the other Nordic countries.

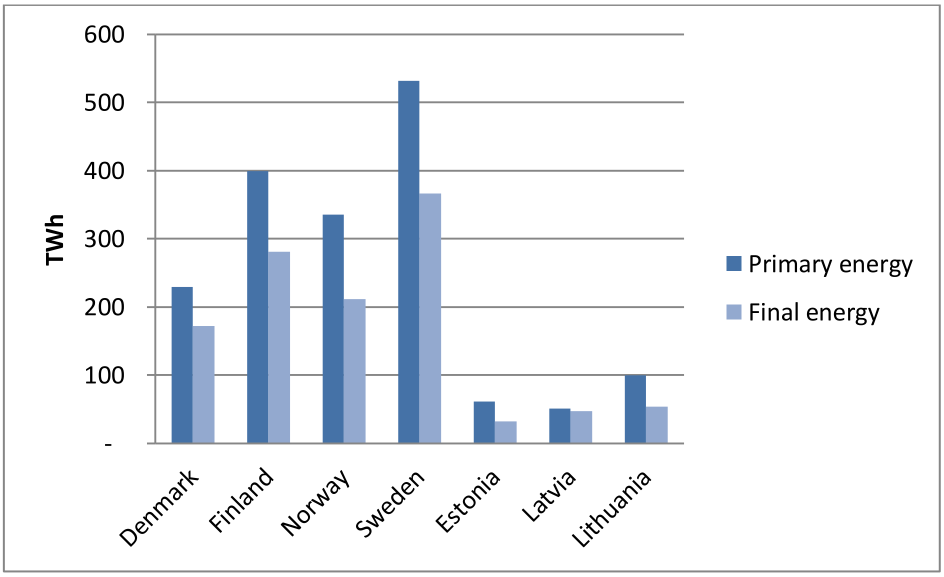

Figure 10: Primary and final energy consumption 2009 (Eurostat, 2012a).

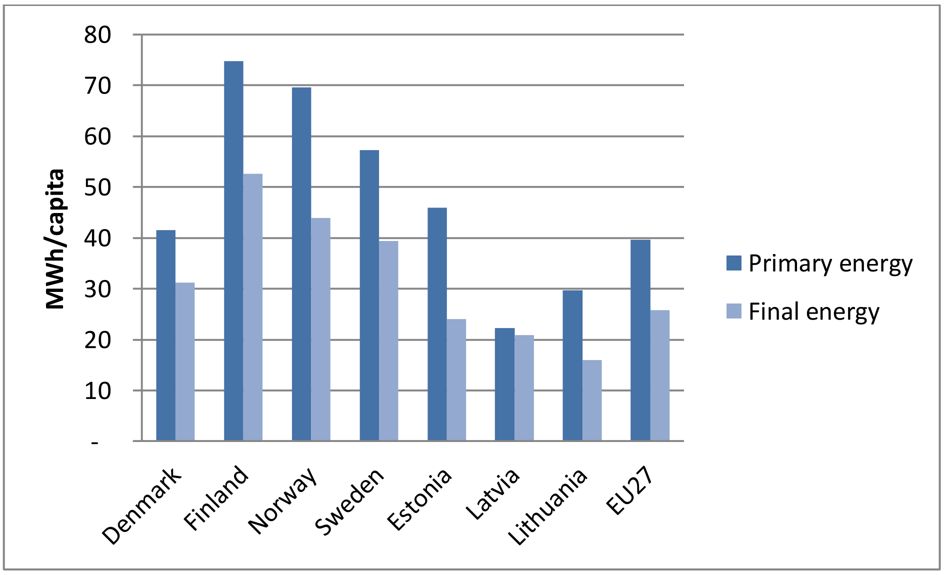

Figure 11: Primary and final energy consumption 2009 per capita (Eurostat 2012a).

To some degree the differences between countries are reduced when energy consumption is related to the number of inhabitants (Figure 11). However, the Nordic countries still have a higher level of consumption. When energy is related to total economic activity (energy intensity), the Baltic countries are at the high end (Figure 12).

The differences in energy intensity do not only reflect the GDP reliance on energy intensive industry but also how efficient the consumed energy is being exploited. Estonia has an energy intensive economy. This is primarily due to the peculiarities stemming from the oil shale-based energy sector of Estonia.

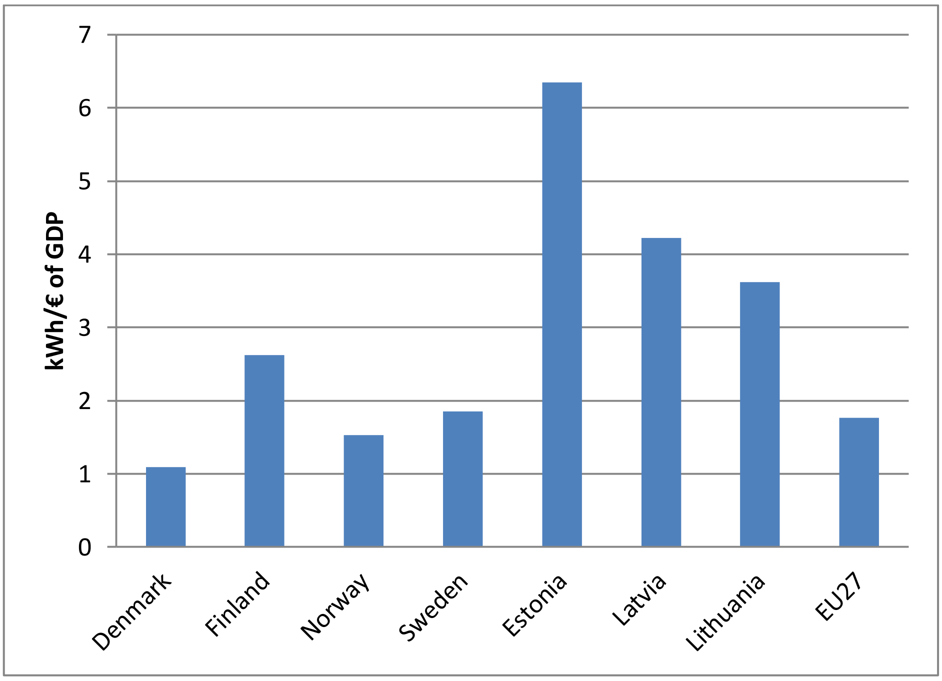

Figure 12: Energy intensity of the economy 2010 calculated on the basis of primary energy consumption (Eurostat 2012a).

Energy consumption in the long run

During the 21-year period from 1990 to 2010, energy intensity decreased in the EU and in the Nordic countries (Figure 13) due to structural changes in the economy and increases in energy efficiency. The sharp drop 1990-1991 for the EU has probably to do with the integration of East Germany and the shutdown of inefficient industrial plants there.

Among the Nordic countries Finland has the highest intensity followed by Sweden, while Norway and Denmark have had a significantly lower level of energy intensity. This can be explained by a higher share of industry in Sweden and Finland. Supporting this interpretation is that the curves for Sweden and Finland fluctuate more than those of Norway and Denmark; energy consumption in households and services is more stable than in industries active in the international market. The gap between Finland (highest) and Denmark (lowest) has diminished somewhat during the period, especially after 1995.

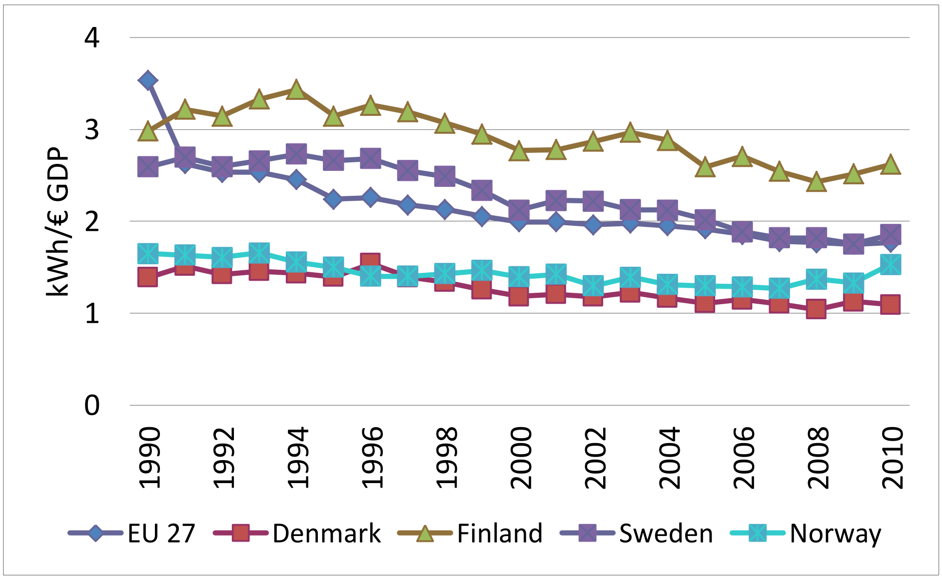

Figure 13: Energy intensity 1990-2010 in the four Nordic countries and in the EU.Primary energy consumption per unit of GDP. (Eurostat 2012a).

The rise in primary energy intensity 2008-2010 can be explained by the stagnation in GDP 2008-2009, while the absolute primary energy consumption increased2009-2010 in three Nordic countries except Denmark (see Figure 14).

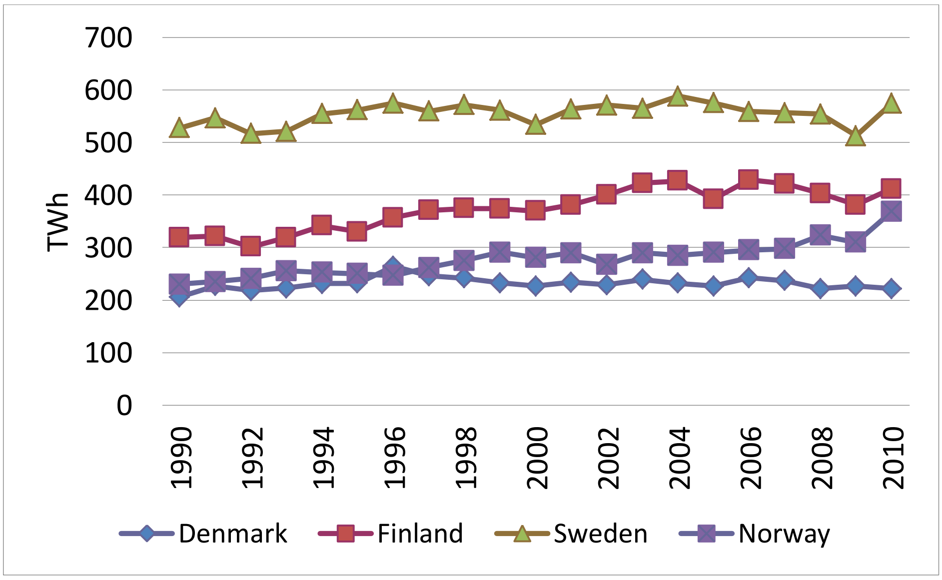

Figure 14: Primary energy consumption in the four Nordic countries and in the EU 1990-2010 (Eurostat 2012a).

Energy dependency shows the extent to which an economy relies upon imports in order to meet its energy needs. It is calculated as net imports divided by the sum of gross inland energy consumption plus maritime bunkers. Please note that the indicator does not reveal the size of the export and import of energy across the border of a given member state – only the difference between the two. Many countries such as Denmark have a large electricity trade with the neighbouring countries while the net import is relatively low.

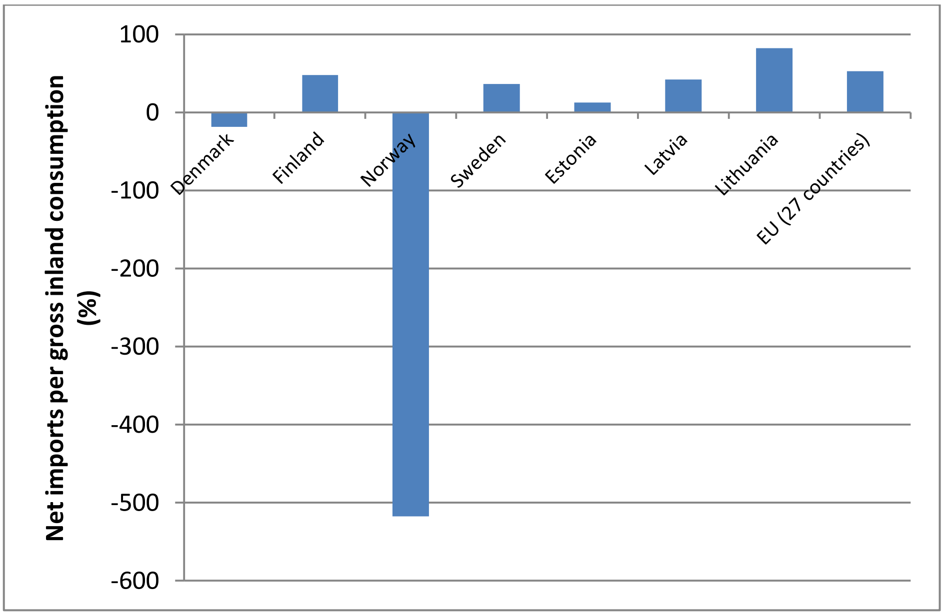

Figure 15: Energy dependency 2010 expressed in net imports per primary inland consumption plus bunkers (Eurostat 2012a).

Consumption by sector

A segregation of the final energy consumption 2009 by sector reveals that the differences between the seven countries are relatively small (see Figure 16). About 40-45 % of the consumption takes places within the industry and transport sectors. The highest consumption in industry can be found in Sweden and Finland (25-30 %) but their consumption within the transport sector is equally small. The highest transport sector share is found in Denmark with approximately 30 %.

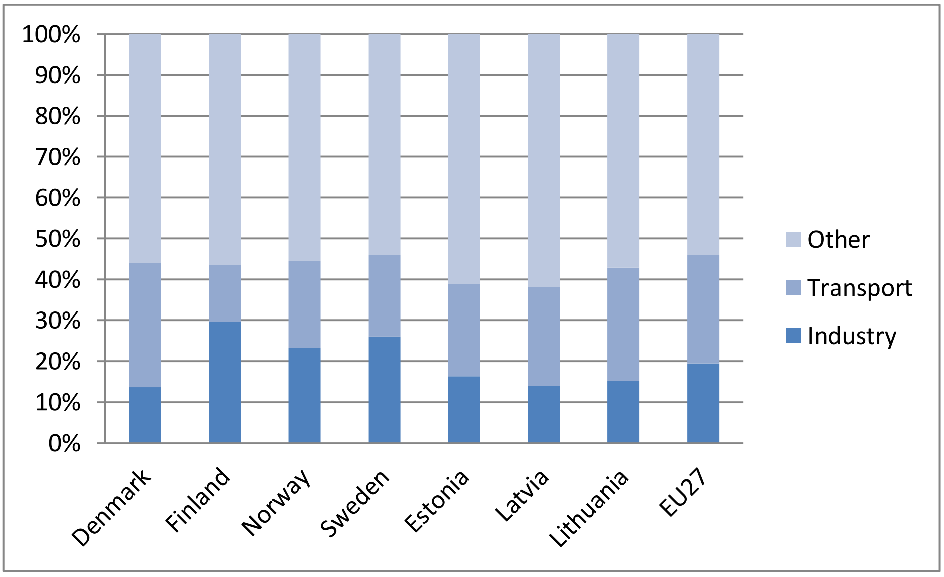

Figure 16: Final energy consumption 2009 by sector (Eurostat 2012a).

Carbon emissions

The energy related carbon emission per capita in 2009 is shown in Figure 17 below. Estonia has a high emission level due to heavy reliance on oil shale while Latvia has the lowest due to a high share of hydro power and biomass.

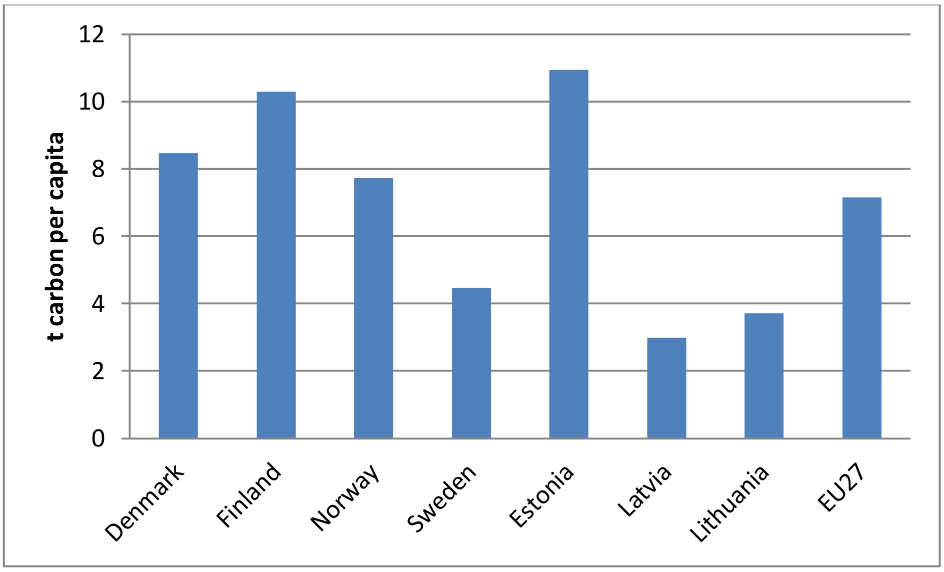

Figure 17: Energy related carbon emissions 2009 per capita (IEA 2011).

Energy tax levels

The energy tax rates differ significantly from country to country with Denmark ranking highest (average among all end-users) as shown in Figure 18.

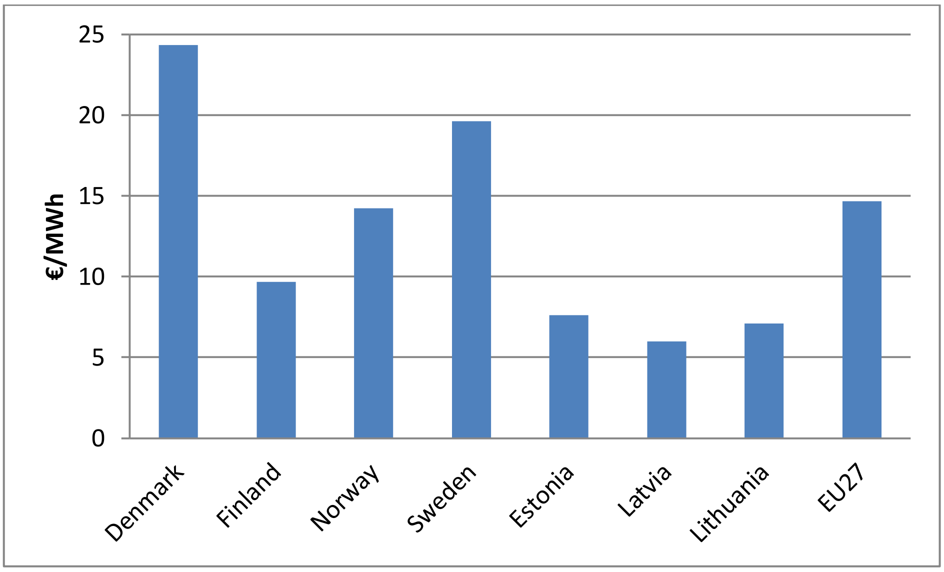

Figure 18: Energy tax rate expressed by the ratio of energy tax revenues per final energy consumption 2009, deflated (Eurostat 2012a).

5 Existing targets and policy instruments

Once a target for energy efficiency has been set a strategy for how to reach this target must be formed and a suitable portfolio of policy instruments composed.

Seen from a rational economical perspective cost efficient energy efficiency measures should in theory occur by themselves if the price signal is in alignment with the energy development objectives. However, this is most often not the case. Another issue is the time aspect. The speed with which the change takes place may not be sufficient to reach the agreed targets in time. It may be necessary to speed up the natural energy efficiency improvement. Furthermore, lost opportunities to harvest energy efficiency improvements for example at the same time as building renovation takes place, may result in lost opportunities or a higher cost for improving energy efficiency at a later stage.

Policy instruments may also be used to engage competent stakeholders in realisation of energy efficiency improvements. Finally, the appropriate choice of policy instrument also depends on the end-use segment in question.

In this chapter a brief overview of the current targets and policy instruments at EU level and national level of the Nordic countries are presented. The national overviews are primarily based on the second national energy efficiency action plans prepared in 2011 while the historical perspective on the policy preferences is based on various sources. A discussion of the Nordic positions of strength in terms of policy instruments can be found in section 5.9.

5.1 Energy efficiency targets

Depending on how a future European energy efficiency target for 2030 is formulated, different portfolios of policy instruments will be effective in reaching the target. A target expressed in final energy consumption would require instruments targeted at end-user consumption, whereas a target expressed in primary energy would also encompass policies targeting the energy sector.

Table 5 presents an overview of the current energy efficiency targets for the EU and the Nordic countries. The EU 2020 target is 20 % saving of primary energy consumption compared to the projections/baseline (PRIMES 2007 projection) in 2020 – the target covers EU as a whole and is not nationally binding (Energy Efficiency Directive, Dir. 2012/27/EU). This is an absolute 2020 goal for EU relative to a business-as-usual reference defined in 2007.

The indicative national target for each member state for 2016 is 9 % of the final energy consumption in 2016 (Energy Service Directive, Dir. 2006/32/EC) – compared to the annual final inland energy consumption of all energy for the most recent five-year period previous to the implementation of the Directive, not adjusted for degree days, structural changes nor production changes. On the basis of this annual average amount of consumption, the national indicative energy savings target shall be calculated once, and the resulting absolute amount of energy to be saved applied for the total duration of the Energy Service Directive.

Level	Energy efficiency targets
EU	2020: 20 % reduction in primary energy consumption by 2020 relative to PRIMES forecast (this equals 1,474 Mtoe primary energy or 1,078 Mtoe final energy consumption). 2016: Indicative national targets of 9 % reduction in absolute final energy consumption by end 2016. (Directive 2012/27/EU) DK 9 % = 15.7 TWh; FI 9 % = 17.8 TWh; SE 9 % = 33.2 TWh.
DK	2020: 7 % reduction from 2010 to 2020 in final energy consumption excluding transport 2050: Carbon neutrality (Denmark 2012)
FI	2020: 37 TWh (approx. 11 %) reduction of final energy consumption including 5 TWh (5 %) reduction in electricity consumption. 2050: 33 % reduction in final energy consumption relative to 2020 level. (Finland 2010)
NO	(2020: 1.7 Mt carbon reduction) 2050: Carbon neutrality including transport (Norway 2008)
SE	2020: 20 % reduction in energy intensity (kWh/SEK) between 2008 and 2020. 20 % reduction in final energy consumption in buildings (kWh/m^2 heated floor area) relative to 1995. 2050: 50 % reduction in final energy consumption in buildings (kWh/m^2 heated floor area) relative to 1995. (Sweden 2008/09; EU 2011a)

Table 5: Current energy efficiency targets.

EU Energy Efficiency Directive

A newly approved Energy Efficiency Directive (October 2012) is to replace the current Energy Service Directive (2006/32) and the Cogeneration Directive (2004/8). In the Energy Efficiency Directive the goals are formulated as "the Union's 2020 energy consumption has to be no more than 1,474 Mtoe of primary energy or no more than 1,078 Mtoe of final energy".

The Energy Efficiency Directive contains no specific target for the individual member states for the period after 2016 but instead contains targets for two policy measures, namely an energy efficiency obligation scheme and systematic renovation of central government buildings (more on these follows below).

The directive opens up for the member states to define their new national targets in either

- Primary or final energy consumption,
- Primary or final energy savings, or
- Energy intensity.

And due consideration will be given to:

- Remaining cost-effective energy saving potential,
- GDP evolution and forecast,
- Changes or energy imports and exports,
- Development of all sources of RE, nuclear, CCS as well as
- Early action.

While the indicative national minimum energy efficiency target for the period until 2016 as specified in the Energy Service Directive excluded counting improvements in supply and network consumption, these are included as of 2016.

Energy efficiency obligation scheme

Member states shall establish an energy efficiency obligation scheme and designate obligated parties amongst energy distributors and/or retail energy sales companies operating in its territory. It is voluntary whether or not to include transport fuel distributors or transport fuel retailers operating in the territory. The target is to save 1.5 % of the average annual energy sales to final customers, with or without energy sales to the transport sector, in the period 2010-2012***.***

The savings counted are lifetime savings. The exemptions to this target include the following but may maximum constitute 25 % of the target:

- Instead of 1.5 % use 1 % in 2014 and 2015, 1,25 % in 2016 and 2017, and 1,5 % in 2018, 2019 and 2020 (which reduces the target for the entire period by 14.3 %);
- Exclude all or part of energy used in industrial activities that are subject to the EU ETS;
- Count savings achieved in the energy transformation, distribution, and transmission sectors; and
- Count energy savings resulting from individual actions newly implemented since 31 December 2008 that continue to have an impact in 2020.

It is possible to count savings obtained in a given year as if instead obtained in any of the four previous or three following years. The savings achieved by each obligated party must be published.

The Energy Efficiency Directive allows member states to choose an alternative approach to an obligation scheme for reaching same amount of savings. Member states are, however, subject to EU approval of such an alternative scheme.

Renovation of central government buildings

The second target specified in the directive is a target for renovation of central government buildings. From 1 January 2014, 3 % of total floor area owned *and* occupied by central government must be renovated every year to meet minimum energy performance requirements. The total floor area only includes buildings with useful floor area (i.e. heated/cooled area) above 500 m^2 (250 m^2 as of 9th July 2015) that do not meet minimum energy performance requirements on 1st January each year. It is possible to count excess floor area renovated in any of the three previous or three following years towards the renovation rate. New buildings occupied and owned as replacements for specific central government buildings demolished in any of the two previous years, or buildings that have been sold, demolished, or taken out of use in any of the two previous years due to more intensive use of other buildings may be counted.

Just as is the case for the obligation scheme, member states may chose an alternative approach to renovation of central government buildings but the choice is subject to EU approval of such an alternative scheme. The net impact of the renovation requirement for central government buildings will however be very moderate compared to the energy efficiency obligation scheme simply due to the fact that only a very small share of the total building stock are owned and occupied by central government.

Other key elements of the directive address cogeneration, heating/cooling, and market barriers such as lack of information (informative billing, smart metering, audits), lack of access to qualified assistance (certification of energy service providers), split incentives, public purchase, bureaucratic obstacles (accounting practices), and availability of data for policy making and monitoring.

5.2 Other existing EU climate and energy targets

EU member states have agreed on a carbon emission target and a renewable energy target.

The renewable energy share target is 20 % of EU's final energy consumption (including losses of electricity and heat in distribution and transmission) expressed as percentage of total 2020 energy consumption (EU climate and energy package). This is a relative goal since it is a share of the total gross final energy consumption.

The carbon reduction target is a reduction in EU greenhouse gas emissions of at least 20 % below 1990 levels (EU climate and energy package) in 2020. This is in reality an absolute goal of 3,956 Mt CO_2 equivalent.

Improving energy efficiency would generally also support the renewable energy targets and the carbon target. With reduced energy consumption it is easier to reach renewable energy targets and carbon emissions might typically be reduced. See chapter 3 for a discussion on the interaction between an energy efficiency target and EU renewable energy and carbon targets.

5.3 Types of policy instruments

Policy instruments can be categorised according to type of instrument: Informative, normative, economic, or a combination of these. Examples of the different types of instruments are illustrated in the figure below.

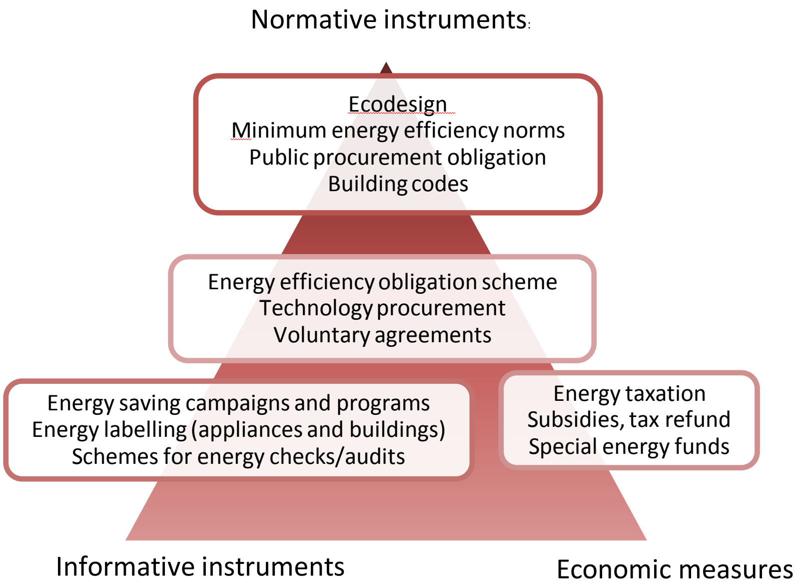

Figure 19: Examples of policy instruments categorised by type.

Looking at the examples from the Nordic countries, the impact of the instruments in reaching an energy efficiency target depends on the formulation and requirements concerning monitoring, evaluation, and additionality.

Target group	Characteristics	Instruments
Heat and power plants	Few stakeholders, focus on energy efficiency	CO_2 quotas
Energy intensive industry	Some with international competition.	CO_2 quotas. Agreements. Subsidies.
Households and other end-users	Millions of decision makers. Little focus on energy efficiency. Major parts of energy consumption outside CO_2 quotas.	Various normative, economic, and informative instruments

Table 6: Examples of appropriate instruments for different target groups.

5.4 Policy instruments at EU level

Some of the policy instruments in force in the Nordic and Baltic countries are a result of EU regulations directly implemented in the member states, others are national instruments implemented to fulfil EU legislation, while others again are a result of national priorities and targets. EU regulation with policy instruments directly implemented in the member states includes the

Ecodesign Directive[11], emission performance standards for cars and vans, and elements of the Energy Labelling Directive.[12]

EU level or national level policies

For some policy instruments it can be an advantage if they are implemented at EU level, as they can ensure a larger effect on the technology development and less technology distortion between the EU countries. An example is the energy labelling and minimum standards for white goods, since these are traded freely across borders and the producers are international businesses serving international markets. For other policy instruments adjusting them to the national context might be a prerequisite for success. A possible EU 2030 target thus has to be flexible enough to accommodate well-functioning national policy instruments. While the chosen national policy instruments should support the EU target and overall development goals.

Flexibility though a balanced approach

At the project workshop 10th May 2012 in Stockholm the importance of flexibility in the member states' possibility to choose measures, and the importance of leaving space for national variations were emphasised by many participants. A recommendation for the EU regarding policy instruments to be extracted from the workshop discussion, would be to choose a balanced approach, where central EU activities should be balanced with a freedom to adapt to national situations, including energy system and policy tradition.

Technology development

Regarding policy instruments at EU level the Ecodesign Directive was discussed as a positive example of a policy instrument that should be at EU level. Ecodesign standards for a number of selected product groups have proven to be successful, and the Ecodesign measures have ensured a combination of market transformation and market integration through common rules for all member states. A general recommendation is that regulation of technology development is best dealt with at EU level to avoid market distortion and to ensure a higher impact. Generally, minimum energy performance standards are favoured by the Nordic countries.

Transport sector

Transport is another example of an area that is being dealt with at EU level. There is large energy efficiency potential in the transport sector, and EU policy measures could potentially have a wide effect. The EU fuel efficiency standards for cars, vans, and heavy-duty vehicles are positive examples of policy instruments at EU level which can be supported by national instruments, such as taxation and infrastructure policy.

[11] Directive 2009/125/EC.
[12] Directive 2010/30/EU.

Instruments	EU level
Informative	• Informative energy bills • Metering and advanced metering systems
Normative	• Ecodesign • Building labelling • Central government building renovation and purchase
Economic	• Minimum energy taxes • (EU ETS) • (Internal energy market)
Combinations/other	• Energy efficiency obligation

Table 7: Current EU energy efficiency policy instruments.

Ecodesign Directive

The Ecodesign Directive has resulted in minimum efficiency norms for a number of energy consuming products. An overview of the products currently addressed is presented below and more are being added.

Technologies	Adopted
Standby and off-mode losses of electrical and electronic equipment (household and office)	December 2008
Simple set top boxes	February 2009
Residential lighting	March 2009
Tertiary sector lighting	March 2009
External power supplies	April 2009
Televisions	July 2009
Electric motors	July 2009
Circulators	July 2009
Residential refrigeration	July 2009
Residential dishwashers	November 2010
Residential washing machines	November 2010
Fans (driven by motors with an electric input power between 125 W and 500 kW)	March 2011
Air conditioners and comfort fans	March 2012

Table 8: Technologies for which minimum standards have been agreed under the EU Ecodesign directive (EU 2012)

5.5 Danish energy efficiency policy instruments

Existing energy efficiency and energy saving measures were formulated in the Danish Energy Policy Agreements from February 2008 and March 2012. The most important measures are summarised in the figure below.

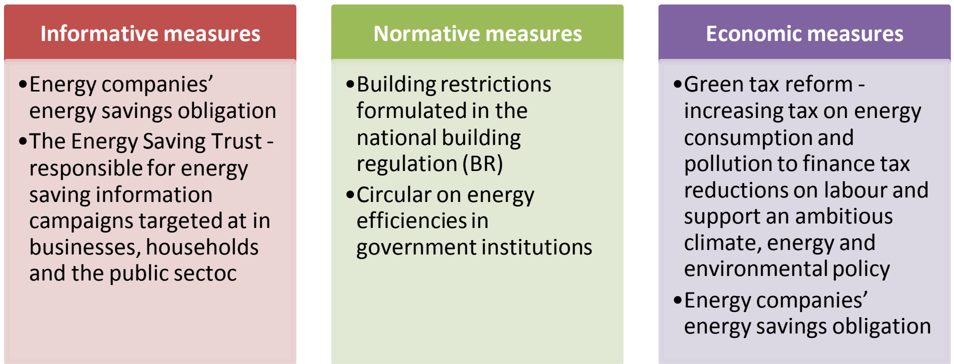

Figure 20: Key Danish energy efficiency policy instruments.

An overview of the current Danish energy efficiency policy instruments is presented below showing the type of instrument (economic, normative, or informative) and the area of consumption at which the instruments are targeted.

An Energy Saving Trust

The Danish Energy Saving Trust (Center for Energibesparelser) was established in March 2010 as a replacement for the Danish Electricity Saving Trust (Elsparefonden) created in 1997. Danish Energy Saving Trust was an independent public organisation with its own board. It was short-lived since it was closed down again in June 2012. The trust's purpose was to further cost-effective energy savings in businesses, households and the public sector. Among other things, this is undertaken by supporting other operators' activities – especially those of the energy companies. The trust was financed by the energy savings charge on energy consumption, which amounts to approximately 90 million DKK/year. In addition to the energy savings charge, the trust managed resources provided in the budget for campaigns to further energy savings in buildings and the Knowledge Centre for Energy Savings in Buildings (Videncenter for Energibesparelser i Bygninger). The Knowledge Centre for Energy Savings in Buildings continues today and 20 million DKK have with the energy agreement of March 2012 been allocated for the period 2012-2015.

Circular on energy efficiency in government institutions

A circular on energy efficiency in government institutions from 1 October 2009 was implemented in 2011. It is not listed in the second Danish NEEAP (and thus not in the table below) but is important for energy efficiency in government institutions. The circular sets out the overall framework for the institutions' activities. Within the overall framework the individual institutions decide themselves what measures to take to meet the objectives. The requirements of the circular include on obligation to reduce energy consumption by 10 % per ministerial area, to display energy efficient behaviour, to report energy consumption, and to ensure energy efficient buildings.

Energy and CO_2 taxes

Denmark has one of the highest levels of energy taxes for households in EU. The most recent green tax reform took place in 2009 and increased the tax on energy consumption, partly to finance tax reductions on labour and partly to support the climate, energy and environmental objectives. The tax reform includes a security of supply charge on energy consumption for heating - which will also have a restraining effect on energy consumption, a general increase of energy tax on heat and electricity in households by approx. 15 %, the introduction of a new energy tax on fuel and electricity in industry, a gradual reduction of the basic carbon allowance for heavy-process companies not otherwise covered by allowances, the introduction of a tax on energy for air-conditioning, an increase of carbon tax to 20 €/t carbon (150 DKK/ton) (NEEAP2 of Denmark).

A new tax decided in 2012 and fully phased in in 2020 ('Security of supply tax') will also cover biomass (4 €/GJ biomass in 2020).[13] Until now biomass have not expose to any energy tax.

Technology procurement

A successful Danish example of technology procurement is the circulation pump program of the Electricity Savings Trust in 2004-2006 that aimed to influence the uptake of energy efficient circulation pumps among households replacing worn-out pumps. The market transformation program included voluntary agreements with circulation pump producers, retailers and installers to develop, produce, and market energy efficient pumps for the residential market, labelling of the pumps, listing of retailers, installers and prices, as well as joint marketing towards the residential end-users.

Energy companies' energy savings obligations

Danish energy companies for electricity, natural gas, district heating and oil have been work actively with promoting energy efficiency the last 20 years. From 2006 the framework was change to create more focus on realised projects and less on energy audits and recommended projects. In March 2012 the

[13] ENS (2012).

Danish Parliament decided to double the obligation so it with be 12.2 PJ (first years savings) from 2015. The cost collected by tariffs is expected to be 200 M€ per year. The scheme has been evaluated in 2008 and 2012.[14] In both evaluations it is highlighted that the system with success is promoting energy efficiency in industry. The 2012 evaluation indicates that efficiency improvements in households are very expensive since the combined end-user and energy company cost is three times higher than the value of the savings. The 2012 evaluation found that 45 % of the project business, trade and services are additional, while only 20 % of the projects within households are additional. The framework for the scheme is expected to be altered before the end of 2012, partly on the basis of the findings of the evaluation.

Savings in the energy consumption of the processing industry covered by allowances are included in the fulfilment of the energy companies' energy savings obligations. As from 1 January 2010, savings within the distribution and transmission networks are also included in the fulfilment of the obligations.

Voluntary agreement

In Denmark energy intensive industry can obtain a carbon tax reduction if they perform energy management and realise profitable energy efficiency projects. Originally, all energy types were included, but today only electricity is part of this system.

Other types of voluntary agreements

The term policy instrument implies a central government involvement. However, other types of voluntary agreements and/or commitments have existed / exist that do not involve a central government administration. Examples include:

- The curve breaker agreements ('Kurveknækker-aftaler') between municipalities and other public institutions and the Danish Electricity Savings Fund.
- The climate municipality agreements between municipalities and the Danish Society for Nature Conservation, where the mayors commit to reducing CO_2 emissions by minimum 2 % year.
- The 'electricity saving municipality of the year' competition organised by the Danish association of electricity companies
- The Covenant of Mayors — a mutual commitment among municipalities of Europe.

[14] EA et al 2008, EA et al 2012

Certification

In Denmark the certification of building energy consultants that can issue a building energy label is 'Sekretariatet for Energieffektive Bygninger'.

Instrument type	DENMARK Policy instrument	Gross energy consumption	Residentail/teritiary	Energy intensive industry	Other industry including agriculture/forestry/fishery	Transport	Energy sector (supply & network)
E	Subsidy for wind power	X					
E	Subsidy for CHP	X					
O	Action plan for more energy efficiency recovery of oil and gas in the North sea 2009-2011	X					
M	Energy savings obligations for energy companies and an increase of the savings target for the effort (buildings, public sector, industry, distribution networks)	X	X	X	X		(X)
N	Building regulations		X	(X)	(X)		
E	Increase of energy tax on energy consumption in households and industry		X	(X)	X		
O	A green transport policy					X	
E	Oil-fired boiler scrap scheme		X				
I	Knowledge Centre for Energy Savings in Buildings		X	X	X		

Table 9: Main policy instruments currently in use in Denmark as presented in the NEEAP2 but without the Energy Saving Trust. E = economic; N = normative; I = informative; M = mixed; O = other.

5.6 Finnish energy efficiency policy instruments

Finland's long-term climate and energy strategy sets energy savings target for energy and electricity end use for 2020. On the basis of this strategy the Government set on 4 July 2010 a 37 TWh end-use energy saving target until 2020 calculated from the baseline scenario.

A key instrument for the fulfilment of the obligations under the Energy Services Directive to reach the target of 9 % energy saving is the **Energy efficiency agreements** which is in force 2008-2016. These and other relevant measures to fulfil the EU and national energy saving targets can be divided into informative, normative, and economic measures:

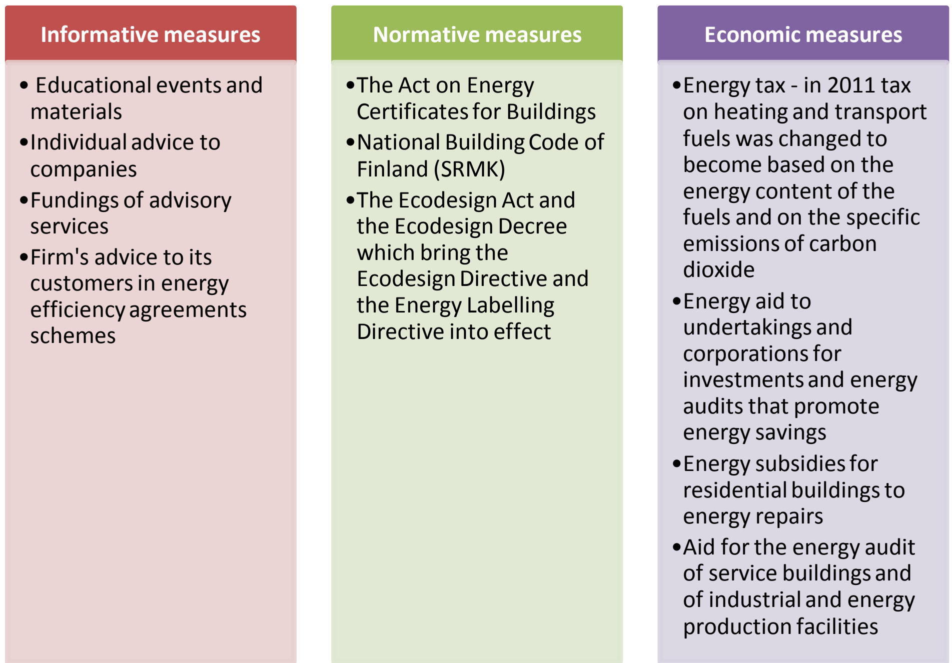

Figure 21: Key Finnish energy efficiency policy instruments.

Motiva is an important agency for energy efficiency in Finland. It was founded in 1993 as a three year Energy Savings Service Centre project. Motiva is now a limited company owned by the state. Its task includes monitoring the Energy Efficiency Agreements, but also pilot projects on energy advice, coordination of the annual Energy Savings Week and Mobility Week, and communication concerning the Ecodesign and energy labelling requirements aimed at consumers.

Energy efficiency in building regulations

For new construction, the energy consumption of buildings is guided by the provisions and guidelines in the National Building Code of Finland (SRMK), which in turn implement the Energy Performance of Buildings Directive. The energy efficiency of buildings has been guided by national legislation since

1976. The building regulations have mainly regulated the properties of buildings relating to the consumption of thermal energy (U-values of the envelope, ventilation heat recovery).

The Ecodesign Act and the Ecodesign Decree

The Ecodesign Directive (2009/125/EC) and the Energy Labelling Directive (2010/30/EU), which concern the energy efficiency of products, have been brought into effect in Finland by the Ecodesign Act (1005/2008) and the Ecodesign Decree supplementing it (1043/2010). Both instruments were updated in late 2010 to reflect amendments to the Ecodesign and Energy Labelling Directives. Their scope was extended from products that use energy to also include energy-related products.

Energy tax

In addition to fiscal targets, energy tax also aims to meet energy and climate policy objectives. Energy taxes on transport, heating and electricity were increased on average by 9.8 % at the start of 2008, whilst keeping the tax structure unchanged. A structural change in the taxation of energy products entered into force at the beginning of 2011, whereby tax on heating and transport fuels changed to become based on the energy content of the fuels and on the specific emissions of carbon dioxide originating from combustion (energy content tax and carbon tax).

Energy efficiency agreements

The energy efficiency agreement scheme that started in 2008 is a continuation of the energy savings agreements that Finland started to enter into with undertakings and local councils in 1997. With the exception of one agreement area, these energy savings agreements ended in 2007. The energy efficiency agreements are a key instrument in Finland for the fulfilment of the obligations under the Energy Services Directive that entered into force in 2006. The agreements will be in force until the end of 2016, and one of their key targets is the 9 % energy saving under the Energy Services Directive. The energy efficiency agreements 2008–2016 cover industry, energy, private services, municipalities and parts of transport, together about 80 % of Finland’s total energy consumption.

In certain cases, energy efficiency agreements are taken into account in the environmental permit process. The requirement originated from the IPPC Directive of the EU Council (96/61/EC, amended by 2008/1/EC) concerning the harmonisation of pollution prevention and control, which requires that the energy efficiency of activities be considered as part of the assessment for the permit.

Communication and advice
The implementation of energy efficiency in Finland has traditionally been supported by long-term communication and advice activities with a specific purpose. Communication, information and advice are used to support both regulatory and financial guidance and voluntary activities. Information and advice are aimed at businesses and local government as well as consumers. Communication and advice activities associated with promoting energy savings and energy efficiency are funded by the state to the tune of approximately 2.5 M€ per annum. Some projects are also funded by businesses and organizations in addition to the state. *The key player in energy efficiency communication and advice is Motiva, which was founded by the Ministry of trade and Industry (now the Ministry of Employment and the Economy) in 1993 as a three year Energy Savings Service Centre project*. Motiva is now a limited company owned by the state, which also promotes the sustainable use of renewable energy and materials. Motiva supports the state administration in the implementation of the national climate and energy strategy and EU Directives, such as the Energy Services Directive. Communication and advice activities are one of Motiva's areas of focus. Motiva's tasks include:

- 24 pilot projects on energy advice targeted at consumers in 2010-2011. The projects were coordinated by Motiva. The energy advice for consumers will continue in 2013.
- An energy efficiency advice project started in 2009, aimed mainly at medium-sized businesses that had signed up to the energy efficiency agreement for business.
- Coordination of the annual Energy Savings Week and Mobility Week which is communication campaigns established at national level are highlighting topical themes in energy efficiency and offering energy-saving tips to businesses, communities and consumers.
- Communication concerning the Ecodesign and energy labelling requirements aimed at consumers is managed by Motiva.

FINLAND Policy instrument	Residentail/teritiary	Energy intensive industry	Other industry including agricul-ture/forestry/fishery	Transport	Energy sector (supply & network)
R&D of new energy efficiency technologies (Green growth 2011-2015 and Electric vehicles 2011-2015)				X	X
Implementation of EU directives	X	X	X	X	X
Energy efficiency agreements	(X)	X	X		X
Subsidies for energy auditing and invest-ments	X	X	X		
Guidelines for energy efficiency in public procurement	(X)				
Energy efficiency action plans for minis-tries and agencies	(X)				
Building codes for new buildings	X	(X)	(X)		
Subsidies for energy renovation of resi-dential buildings	(X)				
Consumer energy efficiency advice centres	(X)				
Energy labelling of cars				X	

Table 10: Main policy instruments currently in use in Finland as presented in the NEEAP2.

5.7 Norwegian energy efficiency policy instruments

The key goal for Norwegian climate and energy policy is for Norway to be carbon neutral in 2050 or earlier. Regarding energy efficiency a target of 20 % increased energy efficiency by 2020 is set on the background of the EU 20-20-20 targets. The target is relative with the development being compared to a business as usual scenario. Norway might also implement the EU 9 % energy efficiency target for 2016 in the near future.

A large part of the energy efficiency effort in Norway is managed by the public enterprise, Enova, who are responsible for managing different funds, programmes, measures etc. The most important energy efficiency measures are summarised in the figure below.

Informative measures	Normative measures	Economic measures
• A low energy program to build up expertise in the industry, implement showcase projects, and for research and development on energy-efficient construction products and buildings • Scheme for energy checks of homes, to encourage people to take simple and effective conservation measures.	• The Building Code includes requirements for the energy performance of buildings • Green certificates - Norway are working on establishing a common market for green certificates with Sweden	• CO_2 tax - currently the most important instrument to reduce emissions of greenhouse gases. • The Energy Fund financing alteration of energy use and production. the fund is financed by a energy levy and by government support

Figure 22: Key Norwegian energy efficiency policy instruments.

The climate agreement from 2008 (Stortingets klimaforlik) define the targets for the Norwegian climate and energy policy. The key goal in the agreement is for Norway to be carbon neutral in 2050 or earlier. Regarding energy efficiency in the production and in the transmission and distribution net, the agreement set a target of 20 % increased energy efficiency by 2020 through reinforcement of the net, reduced net losses, renewal of existing hydropower capacity and easier access to the net for small production units. The target is set on the background of the EU 20-20-20 targets and is defined as a 20 % increase compared to a business as usual scenario.

As members of the European Economic Area (EEA) Norway is obliged to implement EU legislation of EEA relevance. This includes the Energy Service Directive (which set a 9 % energy efficiency target for 2016), that is being evaluated for implementation.

CO_2 emission tax

Norway introduced a CO_2 tax in 1991 as one of the first countries in the world. The CO_2 taxes on mainland activities are generally levied on the use (more precisely the purchase or import) of mineral oils and petrol. The CO_2 taxes on the Norwegian offshore sector are levied on the burning of petroleum and natural gas. In 2011, the CO_2 tax was 222 NOK/ton CO_2 for light heating oil, equivalent to 7.4 eurocents/kWh, and 188 per ton CO_2 for heavy fuel oils. It is also implemented CO_2 tax on domestic use of natural gas and LPG equivalent to 220 NOK/ton of CO_2. This year, the Norwegian government decided to increase the tax on carbon dioxide emissions in the energy sectors by 200 NOK.

Consumer tax on electricity use

The consumption tax on electricity was introduced in 1951. Revenues from the tax were originally earmarked for the expansion of electricity supply. In the early 1970s, the designation is removed, and the tax was put into an annual special tax. Since the tax on electricity was introduced, there have been various reliefs and exemptions for households and some industries such as pulp and paper industry and energy-intensive industries.

Consumption tax on electric energy includes electricity consumed in Norway, whether manufactured domestically or imported. Tax arises on delivery of electricity to the consumer and collected by electricity distribution companies. In 2011, the overall rate is 11.21 eurocent/kWh. This tax rate includes the energy to households, businesses outside the industry and the administration building in the industry.

Investment aid from Enova and the Energy Fund

Enova was established in June 2001 and has been in full operation since 1st January 2002. Enova is an energy agency and its principal task is to implement support schemes, administer the Energy Fund and reach some overall energy policy target expressed in TWh. Enova's mandate is to promote renewable heating and cooling, energy efficiency measures and the introduction of new energy- and climate technologies in the market. Enova's principal tasks and mandate are further specified in an agreement between the Norwegian State (the Ministry of Petroleum and Energy) and Enova.

Enova's priority areas are the promotion of:

- Renewable heat production
  - District heating
  - Small-scale heating plants in building and smaller industries
  - The conversion to the use of renewable heating in the industry
- Energy saving
  - Energy efficiency and energy recovery in the industry
  - Energy efficiency in building
  - Energy efficiency and environmentally friendly heating solutions in households
- New technologies
  - Demonstration activities of new energy and climate technologies in order to contribute to early market introduction

Since 2001 Enova has contracted support to projects in the building and industry sector with estimated energy savings equivalent to a total of 7.9 TWh/year.

The Energy Fund which was established in 2001 is financed by means of a levy on the electricity grid, as well as through allocations from the state budget. The Energy Fund also generates an interest which is included in the Energy Fund budget.

Totally 11.4 billion NOK (approximately 1,434 M€) has been allocated to the Energy fund in the period 2001-2011. For 2012, additionally 240 M€ has been allocated by to the Energy Fund by the government.

In a white paper on climate effort, the Norwegian government proposed to establish a new fund for climate, renewable energy and energy conversion based on Enova's existing Fund for renewable energy and energy conversion. In June 7th, 2012, the majority in the Parliament settled on a climate agreement based on the white paper on climate effort. The Government will establish a climate and energy fund to promote technological advances in industry, under the existing public enterprise Enova. The aim is to develop technology that reduces greenhouse gas emissions. The government also decided that the use of oil-fired boilers by private households will be phased out. Enova will be able to award households grants for the replacement of oil-fired boilers.

Program for energy efficiency in industry

The Norwegian authorities offer a temporary electricity tax exemption for energy intensive industries which participate in an energy efficiency program. Energy intensive companies are offered the possibility to participate in a five-year program, which is based on an Agreement which has to be concluded between the firm applying for the tax exemption and the Norwegian State. The agreement requires that certain energy efficiency obligations be fulfilled, and stipulates penalty arrangements in case the obligations are not fulfilled.

Norwegian Research Council

The Norwegian Research Council has a specific focus on energy efficiency through the research (R&D) program RENERGI. The RENERGI program is thematically limited to energy production – transfer and stationary energy.

The primary objective of the RENERGI program is to develop knowledge and solutions as a basis for ensuring environment-friendly, economically efficient and effective management of Norway’s energy resources, a highly reliable energy supply and internationally competitive industrial development related to the energy sector. Research activities shall also seek to find solutions to global energy and climate challenges as well as the political challenges inherent in Norway’s role and responsibilities as a leading player in the global energy sphere.

Innovation Norway

Innovation Norway is the Norwegian Government's most important instrument for innovation and development of Norwegian enterprises and industry. Innovation Norway has not a direct energy efficiency program, but an environmental technology scheme that supports enterprises that are developing new environmental technology. The environmental technology scheme support technologies which are close to commercialization, which will be built and tested under approximately natural condition. The scheme supports cleaning technologies, more environmentally friendly production technologies, more efficient resource management and technical systems that reduce the environmental impact.

Technical regulation for buildings

New and renovated buildings are subject to strict minimum energy performance requirements[15]. In addition a significant part of heating (40/60 %) must be provided by other energy sources than fossil fuels or electricity. Energy requirement were revised in 2007 and the aim is to reduce overall energy demand in new buildings by approximately 25 %. It has recently been decided that the energy requirements in TEK are to be revised more often and minimum every fifth year.

Minimum requirements for the energy use of energy related products.

The aim with compulsory minimum efficiency requirements is to encourage producers of energy related products to improve the product design in view to lower the energy consumption at their use. This is also an EU initiative through the Ecodesign directive, which has been implemented in Norway.

Information on energy consumption and billing

Information on energy consumption is required on electricity bills. By 1 January 2017 all electricity customers in Norway shall take in use advanced metering system (AMS). AMS means that all households receive a “smart meter” that register their energy consumption on an hourly basis and automatically

[15] TEK 87, TEK 97, TEK 07 with revised edition in 2010

sends information about the consumption to the energy company. AMS allows electricity consumers to have better information about their energy consumption, more accurate billing and opportunity for automatic control of energy consumption. This will contribute to a better distribution of energy consumption and a more flexible energy market.

Energy labelling of buildings

Energy labelling of buildings aims to increase energy performance of buildings. From 2010 all Norwegian buildings are required to have an energy certificate showing the energy use of the building when they are sold, rented or constructed. This is also an EU initiative through the Directive on energy performance of buildings, which has been implemented in Norway.

Energy labelling of appliances

Energy labelling of appliances aims to increase consumers' awareness of the energy use of household appliances through a reliable and clear labelling in their sales points. This is also an EU initiative through the Energy labelling directive, which has been implemented in Norway.

Voluntary agreements

In Norway energy intensive industries can be temporarily exempted from electricity tax if they enter a five-year energy efficiency improvement agreement. The agreement includes establishing a certified energy management scheme and implementation of identified energy efficiency measures with a payback time less than 3 years and the company is excluded from other public support for these measures.[16]

[16] NVE (2009).

Instrument type	NORWAY Policy instrument	Residentail/teritiary	Energy intensive industry	Other industry including agricul-ture/forestry/fishery	Transport	Energy sector (supply & network)
E	CO2 emission tax	X	X	X	X	X
E	Consumer tax on electricity use	X	(X)	(X)		
E	Investment aid from Enova and the Energy Fund (horizontal)	X	X	X	X	X
E	Program for energy efficiency in energy intensive industry (tax exemption)		X			
E	RENERGI – an R&D program by the Norwegian Research Council aimed at energy production, transfer and stationary energy					X
E	Innovation Norway – support scheme for businesses developing new environmental technology close to commercialisation					(X)
N	Building regulations	X	(X)	(X)		
N	Minimum requirements for energy use of energy related products	X	(X)	(X)		
I	Information on consumption and billing including advanced metering systems	(X)	X	X		
I	Energy labelling of buildings	X	(X)	(X)		
I	Energy labelling of appliances	X	(X)	(X)		

Table 11: Main policy instruments currently in use in Norway (ref: Norwegian Oil and Energy Department). E = economic; N = normative; I = informative.

5.8 Swedish energy efficiency policy instruments

Energy efficiency policy in Sweden has often been conducted in the form of programmes. The most recent Swedish energy bills 'En sammanhållen energi- och klimatpolitik – Klimat' and 'Energi- och klimatpolitik – Energi' included an action plan for improving energy efficiency through a five-year energy efficiency programme for the period 2010 to 2014.

The most important measures are summarised in the figure below.

Informative measures

- Low-Energy Buildings Programme - showcasing new build low energy buildings
- Municipal energy and climate advice services - citizens of every municipality have access to a municipal energy and climate consultant
- Research and research programmes form a significant part of the Swedish energy efficiency efforts. Different programmes are in place which focus on research in energy

Normative measures

- The Environmental Code - a mandatory and all-encompassing instrument that covers all activities and actions that have an impact on the environment
- Building regulations - include minimum requirements for buildings with regard to areas including energy management
- Energy certification - requirements for large buildingx occupied by public authorities or institutions that supply public services and is therefore often visited by the general public
- Regional climate and energy strategies

Economic measures

- Taxation of energy - including an energy and a CO_2 tax

Figure 23: Key Swedish energy efficiency policy instruments.

Government energy efficiency programmes

Energy efficiency policy in Sweden has often been conducted in the form of programmes. In 2008 a new programme known as the ‘climate billions investment programme’ included investments for energy efficiency of approximately 60 million SEK/year, while existing energy efficiency measures were also broadened and deepened at the same time. The draft budget for 2009 extended this investment up to 2011 inclusive. On 11 March 2009, the government adopted the bills ‘A comprehensive energy and climate policy – Climate’ (prop. 2008/09:162) and ‘A comprehensive energy and climate policy – Energy’ (prop. 2008/09:163). The energy bill included an action plan for improving energy efficiency through a five-year energy efficiency programme for the period 2010 to 2014. 300 million SEK was allocated to the programme for each of the five years. The aim of the programme is to bolster work on energy and the climate at the regional and local level and actions for information and advice-giving. The public sector is to play an exemplary role when it comes to energy efficiency improvements.

Taxation of energy

The taxes on electricity vary depending on what the electricity is used for and whether the electricity is consumed in the north of the country or elsewhere. Taxes outside the scope of what is harmonised at EU level, include the sulphur tax and the tax on the thermal output of nuclear reactors. In addition to taxation instruments, there are also environmental charges on emissions of oxides of nitrogen when producing energy. The energy tax is paid in respect of fossil fuels. The CO_2 tax is paid per kg carbon emitted for all fuels except biofuels and peat. The general level of the CO_2 tax was increased in January 2010 and amounts to 1.05 SEK/kg carbon. Fuel used to produce electricity is not subject to energy tax or CO_2 tax. The generation of heat is subject to energy tax, CO_2 tax and, in certain, cases, sulphur tax and the nitrogen oxides charge. Biofuels and peat used for the generation of electricity and heat are, in principle, free of tax.

The Environmental Code

The Environmental Code is a mandatory and all-encompassing instrument within the environmental field that covers all activities and actions that have an impact on the environment. The basic provisions of chapter 1 of the Environmental Code aim to promote sustainable development and are to be applied so as to promote economy with energy and raw materials. The general rules of consideration under the Environmental Code state that anyone who carries out an environmentally hazardous activity or implements a measure must be economic with raw materials and energy and, principally, make use of renewable fuels. The Swedish Environmental Protection Agency has overall responsibility for the application of the Environmental Code.

Municipal energy and climate advice services

Since January 1998, Swedish municipalities have had the option of applying for state support to provide advice in connection with the local specifics. All 290 municipalities in Sweden have applied for and been granted subsidies, which means that the citizens of every municipality have access to a municipal energy and climate consultant. The basic subsidy currently amounts to 280,000 SEK/year per municipality, with some additional amounts for larger municipalities.

Research

Research and research programmes form a significant part of the Swedish energy efficiency efforts. Different programmes are in place, which focus on research in energy, including:

- The Energy Systems Programme – focused on energy issues from a broad perspective with various angles of approach.
- AES, the General Energy Systems Studies Programme – aimed at developing systematic and holistic thinking in the switchover of the energy system.
- The Co-ordinated Urban Development Programme – aimed at supporting and promoting inter-disciplinary research and development projects concerning urban areas and urban development.

- The Sustainable Municipalities programme – aimed at supporting the municipal work with transitioning to sustainable energy use.
- The Fjärrsyn Programme – aimed at supporting district heating companies' competitive commercial and technological development.

Regional climate and energy strategies

Since 2008, all Sweden's county administrative boards have been given the task by the government to produce regional strategies for energy and climate issues in the county in question, in collaboration with other regional and local actors. The appropriation directions for 2010 gave the county administrative boards a clearer responsibility to co-ordinate and lead regional work on realising state policy on the energy switchover and reducing the impact on the climate and, in collaboration with other regional actors, to further develop and carry out the work of the regional climate and energy strategies. The Swedish Energy Agency is responsible for supporting the county administrative boards in their work on the regional climate and energy strategies.

Programme for energy efficiency

Programme for energy intensive industry

The Programme for improving energy efficiency in energy-intensive industry, PFE, was introduced in 2004 and operates as a voluntary agreement between a company and the Swedish Energy Agency. Under the agreement, if a company meets the requirements of the PFE programme, it receives an exemption from the energy tax on electricity (0.005 SEK/kWh) that was introduced on 1 July 2004. The PFE provides businesses with greater knowledge of their energy use, which leads, in combination with the measures implemented, to reduced energy costs. Companies that participate in the PFE must, amongst other things, carry out energy auditing and introduce an energy management system and processes for taking account of energy when purchasing equipment that requires electricity and when carrying out future planning, altering or renovating the business. Energy auditing and analysis must be carried out from a system point of view, be both long and short-term and result in measures to increase electrical energy efficiency. Where measures have a return-on-investment time of less than 3 years, companies must implement them during the course of the programme. Estimated results show that the programme works well. The first period (2004-2009) resulted in energy savings of 1.45 TWh/year. The tax exemption within the programme is seen as an important motivation factor to engage the industry as it brings the discussion on energy efficiency measures to the decision making level. Often the energy efficiency measures are profitable in themselves, so the role of the tax incentives is mainly to bring energy efficiency on the company agenda.

The 3rd and last five-year period for PfE has been open for new participants during 2012 and will thus wind up in 2017. A major objection to PfE is that it perceived breaching EU rules on state subsidies because of the tax waiver.

Energy audit scheme

From 2010 to 2014, businesses can apply for support for energy auditing if they have a final energy consumption above 0.5 GWh/year or if they are active in the primary production of agricultural products and have at least 100 livestock units. Businesses can receive grants of up to 50 % of the costs of energy mapping up to a maximum of 30,000 SEK/business.

Low-Energy Buildings Programme

In the spring of 2010, the Swedish Construction Federation was awarded with a 5-year programme for buildings with very low energy consumption (LÅGAN). The aim of the project is to stimulate energy efficiency new builds and conversion. Energy consumption for those projects that receive funding must be at least 50 % below the requirements laid down in the building regulations and the projects must have major value as a showcase.

Technology procurement

Technology procurement processes have in Sweden been successfully implemented in the fields of heating and air conditioning, hot water and sanitation, ventilation, white goods, lighting and industrial processes. The gained experiences could serve as inspiration for technology procurement programmes at EU level.

SWEDEN Policy instrument	Residentail/teritiary	Energy intensive industry	Other industry including agricul-ture/forestry/fishery	Transport	Energy sector (supply & network)
Energy and CO_2 taxes	X	(X)	X	X	X
Environmental code	X	X	X	?	?
Municipal energy and climate energy advice services	X	X	X		
Research and demonstration programmes	X	X	X	X	X
Regional climate and energy strategies	X	X?	X?		
Programme for energy efficiency in energy intensive industries		X			
Energy audit scheme			X		
Low-energy buildings programme	X	?	?		
Technical procurement and market integration	X	X ?	X	X	

Table 12: Main policy instruments currently in use in Sweden.

5.9 Nordic positions of strength

The Nordic countries' energy production and consumption is very different from one another. As illustrated in chapter 4, the proportion of both heavy industry and the energy resources available vary greatly from country to country. This variation influences which policy instruments are successfully used to further energy efficiency in a national context.

Examples are given in the following of effective policy instruments currently in use in the Nordic countries. The list is by no means exhaustive. Some of the instruments described related to one country might also be in place in other countries following the same or a similar model. For a complete list of policies is each of the Nordic countries please refer to sections 5.5-5.8.

Energy taxes

Energy taxes play an important role in the Nordic countries, and have been successful policy instruments in the household and transport sector. However, taxes in the industry sector are often combined with a high share of exemptions, sometimes so frequent and generous that industrial energy taxation is very low. The current EU directive concerning energy taxation is the Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity. A new EU proposal put forward in April 2011 suggests a minimum tax rate based on the carbon content. A comparison of the existing and proposed minimum rates can be seen below in Table 13.

		Current minima (€/GJ)	Proposed minima to be reached by 2018 (€/GJ)
Motor fuels			
	Petrol	11.38	11.42
	Gas oil	8.59	10.16
	LPG	2.33	9.33
	Natural gas	2.60	10.70
Heating fuels			
	Gas oil	0.55	1.49
	Heavy fuel oil	0.34	1.52
	Natural gas	0.15	1.27
	Coal and coke	0.15	2.04
Electricity		0.14	0.15

Table 13: Current and proposed EU energy and energy product minima tax rates (EU Taxation and Customs Union (2012)).

At the project workshop in May 2012 taxation at EU level was discussed. The majority of participants agreed that higher energy taxation at EU level would be beneficial for the member states, as it would avoid practices that distort competition between member states. It was understood that it would be difficult to reach agreement at EU level for significant taxation levels, however, the EU taxation level could be increased while still allowing room for a higher national level of energy efficiency ambition.

Minimum energy performance standards

Minimum energy performance standards are favoured by the Nordic countries. Building codes set the energy efficiency standard for new and existing buildings and Ecodesign standards for a number of selected product groups have been successful. Ecodesign is a combination of market transformation (changing the supply of products in a certain direction) and market integration (common rules for all member states). However, there is in some cases a need for flexibility with regard to details, tempo, and priorities of implementation.

Public procurement

Public procurement is a requirement that the public institutions adhere to certain energy efficiency or sustainability criteria when procuring goods and services. Public procurement measures could potentially be defined at EU level to strengthen the commitment in the member states and the recently approved Energy Efficiency Directive has to some extent done so: The requirement in Article 6 is that *member states shall ensure that central government bodies and encourage that other public bodies purchase only products, services and buildings with high energy efficiency performance*.[17]

Public procurement is widely used as a policy instrument in the Nordic countries. Public procurement can be used to set a good example and is a valuable instrument for several reasons:

- Making the public sector a forerunner serves to legitimises energy efficiency policy and measures.
- It helps to promote and diffuse new efficient products and energy management systems, and speeds up the diffusion of already known and tested products and systems.
- The public sector can act as a show-case e.g. for electric cars or renewable fuels for buses and can give impetus for construction of related infrastructure. However, the role of the public sector as a driver for energy efficiency investments in the private sector is not unequivocal. Complementary regulation may be necessary.

Voluntary agreements

Voluntary agreements are another area where the Nordic countries have valuable experiences. Barriers to energy efficiency exist even within energy intensive industries, where great attention to energy management and energy efficiency would be expected. Voluntary programmes, often with public-private cooperation and forums for dissemination of experiences and advice, have proven to be a valuable instrument for improving the energy efficiency level among other within the industry sector, frequently in combination with tax exemptions or grants.

[17] Dir. 2012/27/EU.

Informative instruments

All the Nordic countries have placed great effort in creating awareness and knowledge in the general population and among specialist concerning energy efficiency matters. Certification of energy auditors and installers of for example heat pumps are just two examples. And the sensitivity to the energy efficiency topic is introduced already in the early stages of the education systems and included in school curriculum requirements.

Visibility and recognition

Lending greater visibility to frontrunners and success stories can also function as leverage for a greater energy efficiency uptake. An example of such an initiative is the 2011 competition arranged by the Nordic Council of Ministers to reward municipalities that have done an extraordinary effort to realise ground breaking energy projects and use these to showcase sustainable energy, green growth and energy related climate initiatives in the Nordic countries. One aim of the competition was also to highlight that support from business, organisations, citizens, and authorities is needed to achieve our joint targets. Participating and winning municipalities have been promoted at various international events.

5.10 Nordic evaluation of Ecodesign and Energy Labelling directives

Four experts representing Denmark (DK), Finland (FI), Norway (NO) and Sweden (SE) were asked four questions about experiences and views on the Ecodesign and Energy Labelling directives. Norway, being a member of the EEA, has implemented the Ecodesign Directive, but not the Energy Labelling Directive. An edited version of the answers follows below.[18]

1. What is the advantage of common tools and instruments at the EU level instead of at the level of each individual country?

(DK) states that minimum energy performance standards require a reasonably large market in order to function efficiently. A large market means that a large number of products in use are targeted, and a large market reduces management costs per product. National regulations would not be cost efficient. (FI) stresses also the costs for background work and the need for large markets, and adds that energy efficient products can be diffused to those countries where energy efficiency is not a top priority. (SE) replies that common stand-

[18] Answers were delivered from Peter Nielsen (DK), Outu Kumpuvaara (FI), Kirsti Hind Fagerlund (NO), and Nils Ahlén (SW).

ards promotes trade within the EU, and (NO) answers similarly but refers to trade within the EEA.

2. Are there any first-mover advantages for a country in testing new policy instruments or new technologies?

While (DK) and (FI) give short answers indicating only small advantages. (NO) has no suggestions. (SE) states that there is an advantage as the frontrunner establishes a benchmark for other countries to follow, and that it also raises the general efficiency level within that country. (SE) adds that it has positive experiences from working with minimum energy performance standards issues, and that (SW) often choses to be the frontrunner.

3. What is working well and what less well in the current directives?

(DK) points at three aspects of the directives that are not satisfactory: 1) Third party verification is not required in the directives on information about energy efficiency from producers, something that creates problems in cooperation among concerned countries; 2) There is a lack of political will to change the scale used for energy labelling, which now admits A++ and A+++; and 3) It takes too much time from preparatory studies until a law is put in place. (FI) points at something close the latter, namely that background analyses often are outdated when regulations are implemented, and stresses that the Commission must have the means to act efficiently when new products enter the market making old regulations out of date. It is confusing to deal with two directorate-general (DG ENER and DG ENTR): “It is not always obvious with whom to be in touch in the Commission”.

While (SE) delivers a very positive answer, (SE) still points to the different conditions among the countries, due to climate and other natural differences, or the effects of the financial and euro crisis that hits certain member states especially hard. Such differences make it either hard to harmonize standards, or for some countries to take part in negotiations and implementation. (NO) states that the common rules work well, but points also to the problem of how to measure the amount of electricity used for electrical products. (NO) prefers delivered energy as the definition, as this gives the consumer the most adequate information through energy labels and is not subject to variations in energy production. Even though it is impossible to have differentiated conversion coefficients for products crossing borders the conversion rate of 2.5 has no relevance for increases in electricity production, a better option is the long-run marginal production where renewable power production has a bigger weight.

4. What are the deficiencies (gaps) in these directives?

(DK) states that it is better to separate energy efficiency matters from other environmental aspects of products: One cannot regulate both energy and environment through the same law. (FI) replies that special national circumstances are sometimes not paid due attention and that consultants have too much influence through their background reports. (NO) is of the opinion that the responsible party in some cases is not defined when a product fails a test: Who is to be charged, the importer of a product or the exporter? In the former case it is the responsibility of the markets surveillance in the importing country to carry out the control, in the latter case the responsibility is that of another country. Responsible parties are not defined in the directives. (SE) delivers the most positive answer: There are always problems with new laws, but as the countries' representatives meet quite often, problems are overcome.

In conclusion it must be said that the four countries are positive towards ecodesign and energy labelling. The stress on problems associated with these instruments is natural for concerned parties as they wish to improve this relatively new type of common regulation. The primary advantage is the large size of the affected market, which also makes management costs defendable - it is cost efficient. With regard to the criticism conveyed it is harder to come to a clear conclusion. Perhaps the long time-gap between the initiation of preparatory studies and the final regulation is worth stressing. However, there is no indication as to the frequency of this problem in the answers delivered from four Nordic countries.

6 Illustration of 2030 targets and instruments

A number of simulations have been carried out with the energy model STREAM[19] to illustrate the impacts of different targets and instruments. The simulations are made for the four Nordic countries – Denmark, Finland Norway and Sweden – as one area, in order to give a joint Nordic perspective.

How the STREAM model works

In the STREAM model, the demand for *energy services* is converted into a demand for *final energy* (energy delivered to end-users) which again in converted into a primary energy demand. Electricity and district heating as well as for example refined mineral products are produced at energy facilities (power plants, refineries etc.) where energy losses occur. Losses also occur in the transmission and distribution – this is the *conversion* loss on the supply-side. Losses also occur on the demand-side in the conversion from final energy to energy services. The chain is illustrated in Figure 24.

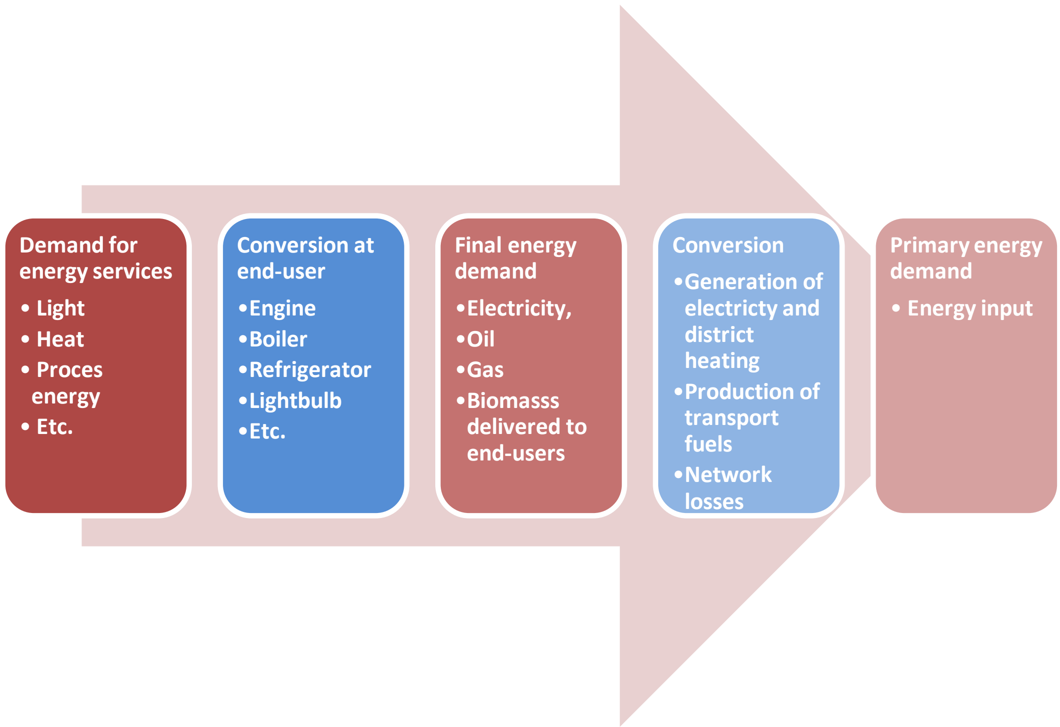

Figure 24: Energy chain in the STREAM model – the arrow indicates the model steps (network losses both include transmission and distribution losses).

In order to be able to easily track the different steps in the calculation and to simplify the results, the energy consumption is only split into three consumer segments, namely:

[19] See STREAM (2012).

- Residential and service sector, which considers electricity for appliances and lighting and energy for heating (fuels, district heating, and electricity).
- Industry sector (process and non-process end-uses), which considers electricity for appliances, motors etc. and energy for process heat (fuels, district heating, and electricity).
- Transport sector.

Only policy instruments addressed at the two first sectors are analysed in this project. The consumption of the transport sector is, however, included in the total consumption figures presented.

Electricity is generated from a mix of technologies – hydro power, wind power, gas driven CHP, and condensing power (coal) – whereas district heating is supplied from CHP plants and heat boilers.

The year 2010 is chosen as base year, and 2030 is chosen as final year for the projections.[20]

6.1 Consumption of energy in 2010 (base year)

The total primary energy consumption in 2010 was 4,868 PJ while the total final energy consumption in 2010 was 3,891 PJ.

The final consumption of electricity and heat in the residential and service sector was 1,480 PJ, with 380 PJ electricity consumption for appliances and 1,100 PJ total heat supplied.

The heat consumption was distributed as illustrated below in Figure 25.

[20] Data for the base year is taken from Eurostat and other relevant EU statistics. In some cases data from 2008 and 2009 is used, as more updated data has not been available.

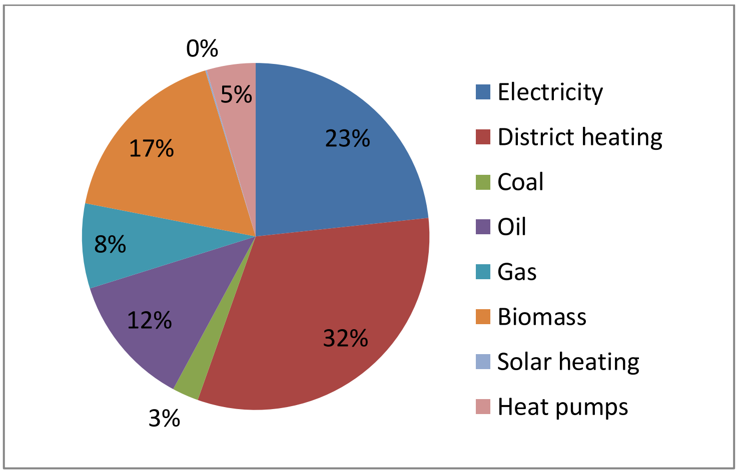

*Figure 25: Final **heat** consumption in the **residential and tertiary sector** in 2010 (base year) (The contribution from heat pumps is only the electricity input[21]).*

In industry the electricity consumption for appliances was 522 PJ and consumption of process energy 888 PJ. The distribution between energy types in process energy was as illustrated in Figure 26.

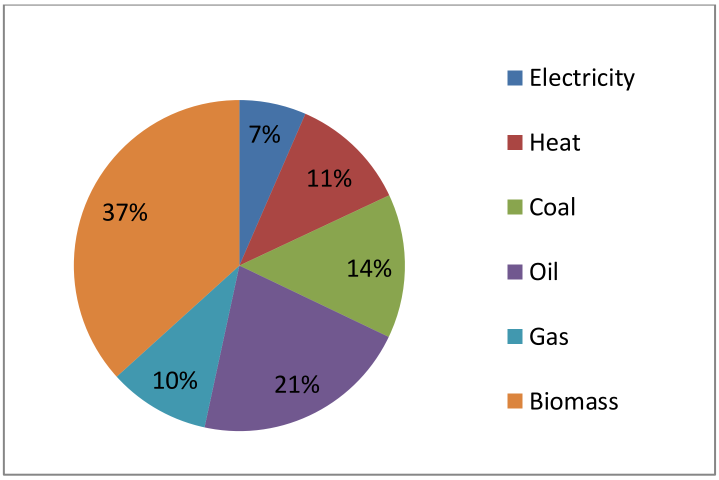

*Figure 26: Final energy consumption for **process energy in industry** in 2010 (base year). (Heat includes district heating and steam from other industrial plants).*

Electricity and heat generation 2010

The total primary energy input to power production amounts to 1,460 PJ (406 TWh) in the base year, with 50 % coming from hydro power, 22 % from nuclear power, 12 % from coal plants, 6 % from natural gas plants, 6 % from biomass, 2.5 % from onshore wind power, 0.5 % from offshore wind power, 1 % from waste incineration, and 0.5 % from biogas plants.

[21] The contribution from heat pumps is calculated as electricity input in final energy, which is the method used in a number of the Nordic countries. No standardised method exists at EU level.

The primary energy input to district heat production amounts to 535 PJ out of which 70 % is produced by CHP production, 12 % from wood pellet boilers, 6 % from municipal waste, 4 % from heat pumps, 4 % from natural gas boilers, 2 % from coal boilers, 2 % from oil boilers, and less than 1 % from electric boilers. The remainder is made up of other energy carriers.

6.2 Scenarios for 2030

Assumptions

Projections are made for the development under different target formulation assumptions. A reference scenario is set up for comparison. The reference scenario works as a frozen policy scenario, only including the effect of policies in place before 2010, and is based on data from the reference scenario in the publication `EU energy trends to 2030 – Update 2009´.[22] The reference scenario includes policies adopted before December 2009 and assumes that national targets under the Renewables Directive 2009/28/EC and the GHG Effort Sharing Decision 2009/406/EC are achieved in 2020. An overview of the assumptions of each target scenario can be found in Table 15.

The reference scenario 2030

From the data in the `EU energy trends to 2030 – Update 2009´ some general trends in the Nordic countries can be extracted:

- Final energy demand in all countries decreases only slightly in 2030 compared to 2010 (the base year).
- There is no clear tendency regarding sector specific changes. In Finland the final energy demand in industry is expected to increase slightly while it is set to decrease in the other countries. In the residential and tertiary sector, Denmark is the only country where a slight increase is expected.
- For all countries a small decrease in the transport sectors' final energy demand is expected.

2030 final energy similar to 2010

These general trends are incorporated in the model reference scenario and the total final energy demand in 2030 in both the residential and tertiary sector as well as the industry sector is projected to be roughly at the same level as in 2010.

[22] EU (2010b). The scenarios in the report are developed with the PRIMES model, which is a modelling system that simulates a market equilibrium solution for energy supply and demand in the EU27 and its member states. The scenarios include relevant policies and measures implemented in the member states. The scenarios build on macro projections of GDP and population which are exogenous to the model used. The energy projections are based on a relatively high oil price environment compared with previous projections and are similar to reference projections from other sources, such as for example the IEA (2009). Regarding energy technology progress, the scenarios takes into account energy efficiency gains, penetration of new technologies and renewables, as well as changes in the energy mix driven by relative prices and costs.

Looking at final energy demand by fuel, the general trend is that the oil consumption decreases while the electricity consumption increases. Again there is no strong trend to extract from the data. The consumption of renewable energy increases linearly and significantly over the whole period.[23]

Electricity generation is expected to increase

Looking at the electricity generation in the Nordic countries the total generation is expected to increase in all countries. The same applies to the share of biomass and the share of wind power. The share of fossil fuels is expected to decrease in all countries. Other than this the trend differs in each country. For Denmark the expected increase in wind energy and the share of fossil fuels in the electricity generation is adjusted as recent national policy changes is expected to increase the share of wind to just below 50 % of total electricity consumption and decrease the share of fossil fuels for electricity and heat production by 2020.[24]

Economic growth

The annual economic growth in the period from 2008 to 2030 is set to 1.75 % p.a. for both the industry sector, as well as the residential and tertiary sectors. For transport of both goods and persons EU expects the economic growth to be slightly smaller and it is thus set to 1.2 % p.a.

Relation between GDP and energy consumption

Here it is important to notice that the GDP growth rate is not translated into energy consumption 1:1 as a number of factors in the model are not totally dependent on GDP, such as consumption of district heating etc. Different elasticity factors are used to express the relation. For heat consumption in both the residential and tertiary sector the elasticity factor is 0.5. For electricity use in residential, tertiary, and industry and for process heat use in industry the factor is 0.9. For transport the elasticity between economic growth and energy consumption is 1.0.

Primary and final energy consumption in 2010 (the base year) and in the reference scenario is illustrated in Figure 27, Figure 28 and Figure 30.

The total final energy consumption in the residential and tertiary sector only falls 31 PJ during the 20-year period. Oil and coal consumption decreases as

[23] In the `EU energy trends to 2030 – Update 2009´ (EU 2010b) the demand for renewable energy is expected to increase up to 2020 and then decrease again after, as no new renewable energy measures for the period after 2020 is in place. This fluctuation is not included in the modelled reference scenario for the Nordic countries.
[24] Cf.Denmark (2012).

does the electric heating. On the other hand the demand for electricity for appliances and lighting is expected to increase.

In the industrial sector it is in particular the final energy consumption of natural gas that is reduced. The change in total final consumption from 2010 to 2030 is a reduction of 51 PJ.

With regard to the primary energy consumption the main change is an increased consumption of bioenergy and wind power and a decrease in coal and oil consumption. The consumption decreases from 4,868 PJ in 2010 to 4,783 PJ in 2030. The total primary energy consumption in 2030 amounts to 4,783 PJ while the total final energy consumption in 2010 was 3,743 PJ.

The relatively constant development in total energy demand is a result of a number of opposite trends. Economic growth is expected to cause an increasing demand for energy and transport services. On the other hand, the technological development – among other things encouraged by active energy policies and incentives to consumers and energy companies – will lead to improved energy efficiency both with respect to end-use appliances and buildings and in the energy sector.

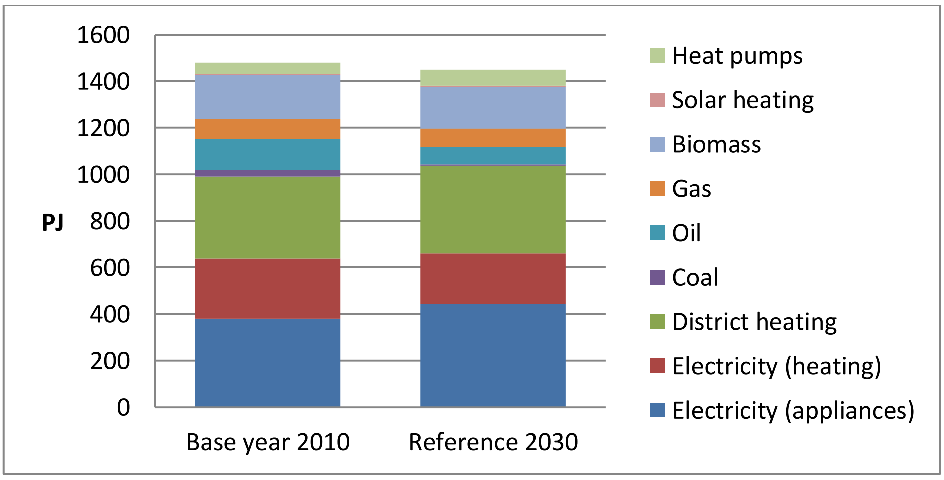

*Figure 27: **Final** energy consumption (PJ) in the **residential and tertiary** sector in 2010 (base year) and in the reference projection for 2030 (heat pumps are calculated as electricity input).*

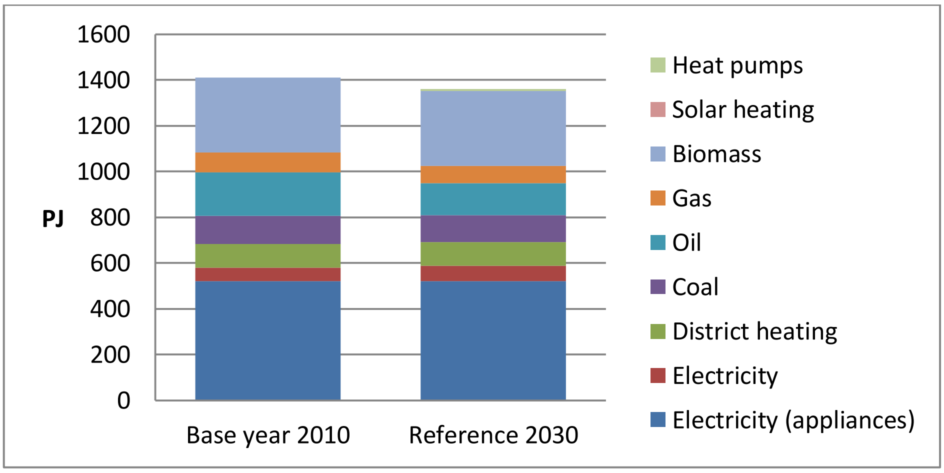

*Figure 28: **Final** energy consumption (PJ) in **industry** in 2010 (base year) and in the reference projection for 2030 (heat pumps are as calculated electricity input). A distinction is made between electricity used for process heat and space heating and electricity used for appliances.*

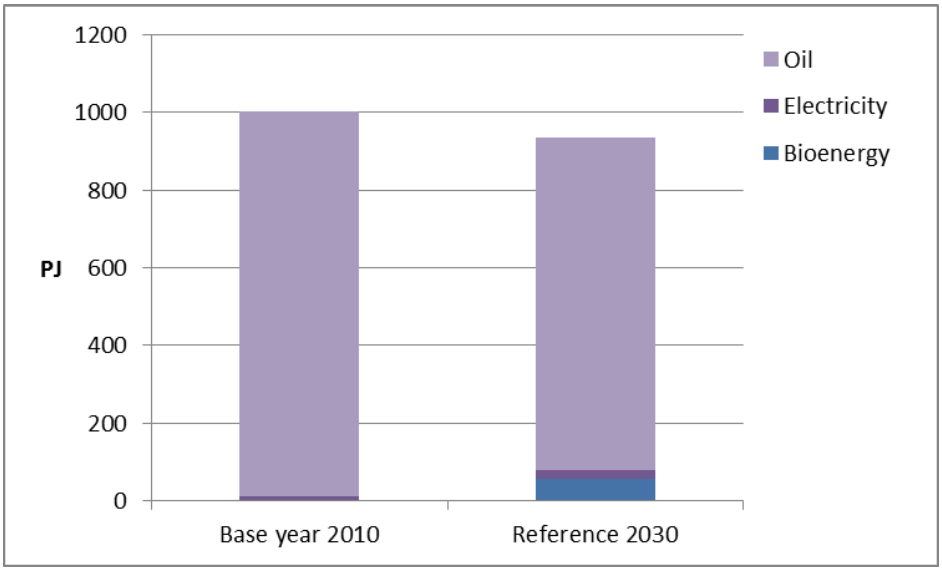

*Figure 29: **Final** energy consumption (PJ) in the **transport sector** in 2010 (base year) and in the reference projection for 2030.*

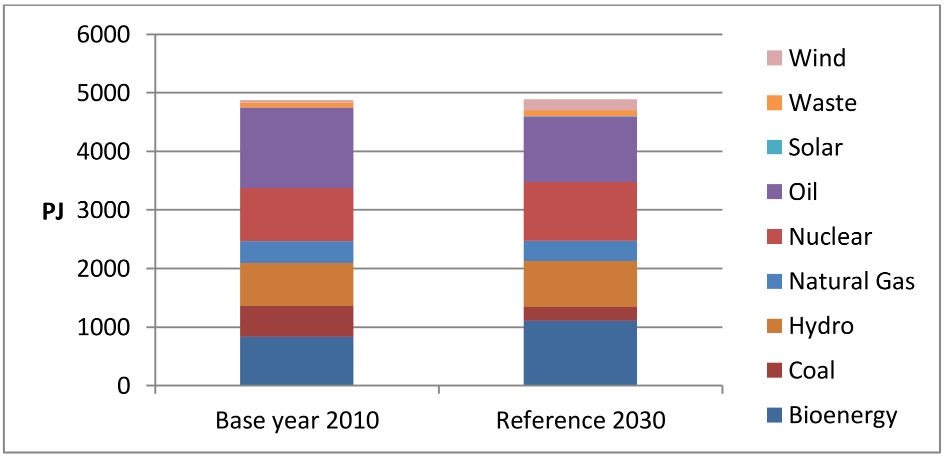

*Figure 30: **Primary** energy consumption (PJ) in 2010 (base year) and in the reference projection for 2030 (excluding net import of electricity).*

6.3 The impact of different 2030 target designs

In order to illustrate the strengths and weaknesses of the different target designs, as discussed in sections 3.2 and 3.3 a set of four additional scenarios is created.

A 15 % reduction level is chosen based on projections from the `EU Energy Roadmap for 2050´.[25] Here the scenarios show a decrease of 12-17 % from 2010 to 2030 in order to meet the long-term target for EU of 80-95 % carbon reduction in 2050. The 15 % should not be regarded as a recommendation but rather as a credible example.

Targets	Primary energy consumption (Figure 31)	Final energy consumption (Figure 32)
Absolute	**Scenario AP** 15 % reduction in primary energy consumption in 2030 compared to 2010	**Scenario AF** 15 % reduction in final energy consumption in 2030 compared to 2010
Relative	**Scenario RP** 15 % reduction in energy intensity in primary energy consumption per GDP in 2030 compared to reference for 2030	**Scenario RF** 15 % reduction in energy intensity in final energy consumption per GDP in 2030 compared to reference for 2030

Table 14: Four alternate target scenarios.

[25] On 15 December 2011, the European Commission adopted the COM(2011) 112 final 'Energy Roadmap 2050'. The EU is committed to reducing greenhouse gas emissions to 80-95 % below 1990 levels by 2050. In the Energy Roadmap 2050 the Commission explores the challenges posed by delivering this objective while at the same time ensuring security of energy supply and competitiveness.

For each of the four scenarios three cases of growth are analysed:

- 0 % GDP growth per year,
- 1.75 % GDP growth per year (similar to the reference scenario),
- 3 % GDP growth per year.

The results of the scenario analyses are presented in Figure 31 and Figure 32. The bars represent the energy consumption while the squares and triangles represent the reduction targets. The figures clearly show how the gap between 2030 target and the projected energy consumption changes with different economic growth assumptions.

With an absolute target measured in primary energy consumption (scenario AP, Figure 31) a 0 % growth results in target achievement without any extra energy efficiency efforts while a 3 % growth results is a significant difference between target and actual primary energy consumption. The same holds true if the target is expressed in final energy consumption (scenario AF, Figure 32). If on the other hand the target is expressed in relative terms i.e. energy intensity (scenario RP in Figure 31 and scenario RF in Figure 32) then the challenge to align the actual consumption with the target remains irrespective of the level of growth in the Nordic region.

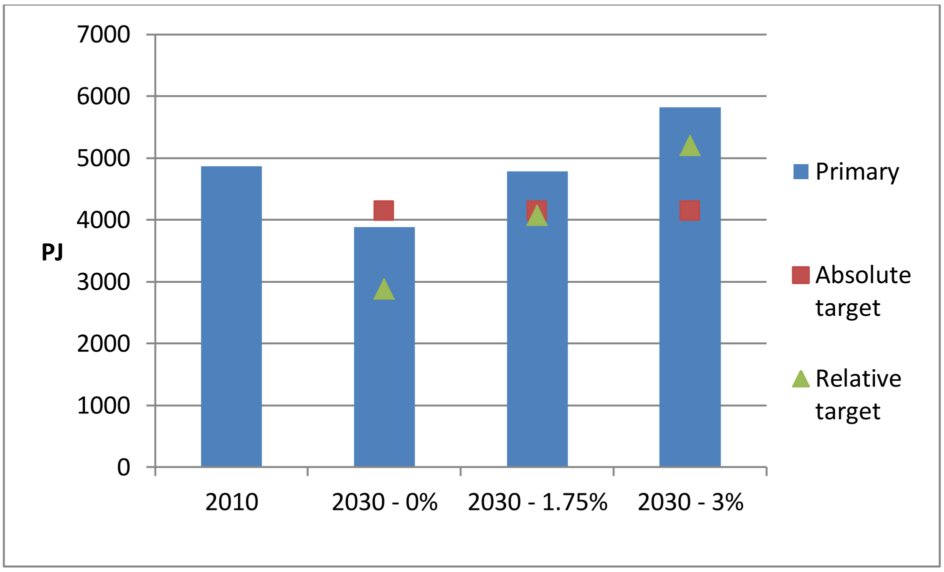

*Figure 31: **Primary** energy consumption and **scenario AP and RP target**.*

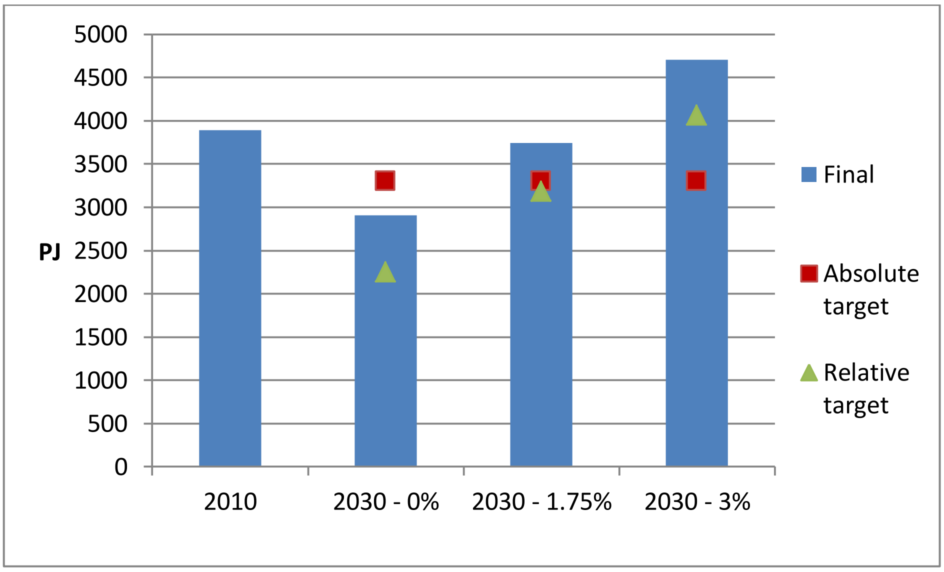

*Figure 32: **Final** energy consumption and **scenario AF** and **RF target**.*

6.4 Impact of the choice of policy instrument

Six different energy efficiency policy scenarios have been modelled with the aim to illustrate the difference in the possible impact of these selected policies on the primary and final energy consumption. The six scenarios represent a palet of well-known technologies.

This exercise illustrates that different policies have different impacts on final and primary energy consumption and that for example an energy efficiency target defined in final energy might benefit differently from different policies compared to a target expressed in primary energy.

The impact of each instrument by 2030 is compared to the reference scenario and illustrated as an 'alternative scenario'. Each policy scenario thus represents an isolated change in energy efficiency or technology shift. In reality a multitude of changes would take place as a result of policies initiated. The scenarios are thus not to be construed as a suggested development pathway nor a likely development but the effect of different isolated instruments. In practice the impact of each improvement will affect the impact of other improvements in place. As the projected impacts only serve as illustration these mutual effects are less relevant.

The six scenarios are presented in Table 15.

It should be noted that the projections are highly uncertain. This is among other things related to the choices regarding marginal production technologies for heat and power. Marginal production technologies are the technologies used to create flexibility in the power and heat production to adjust to consumption levels and market prices. The national priorities regarding marginal production technology differ from country to country. This constitutes a challenge when projections are made for the Nordic region as one joint area as the technologies have different efficiency levels and the choices thus effect the total consumption of primary energy.

Area	Reference assumption	Scenario assumptions	Model adjustments
A) Share of CHP	The share of electricity-only (condensing) in the production from thermal plants is reduced from 19 % in 2010 to 10 % in 2030.	Scenario A The electricity-only share is reduced to 5 % in 2030.	The extra heat supply from CHP is adjusted by reducing the supply share from boilers using fossil fuels (oil coal and natural gas) for heat production only.
B) Building insulation	The building heating loss is reduced by increasing the energy efficiency and thus reducing heat consumption with 15 % by 2030 in the residential and tertiary sector.	Scenario B The heat consumption is reduced 30 % instead of 15 %.	The scenario lead to a 59 PJ reduction in electricity demand compared to the reference. 29.5 PJ (50 %) is exported and 29.5 PJ (50 %) is reduced production from thermal plants (coal, natural gas and biomass). The reduction in heat demand is adjusted by reducing the share of district heat production from heat only boilers and heat pumps.
C) Efficiency of lighting and other electric appliances	15 % energy savings for electric appliances in the residential and tertiary sector by 2030 and 27% savings in industry.	Scenario C 25 % energy savings in the residential and tertiary sector and 37 % in industry.	The reduced electricity demand (125 PJ) is adjusted in the same way as scenario B. The reduction in heat production from CHP is adjusted by increasing the share of district heat production from boilers, heat pumps and solar heat.
D) Boiler and heat pump efficiency	The efficiency in all individual boilers is increased 10 %. Heat pump efficiency is increased from 2.75 COP to 3.0 compared to 2010.	Scenario D Boiler efficiency for individual boilers in the residential and tertiary sector is increased by 5 % compared to reference. Heat pump efficiency for individual heat pumps is increased to 3.5 COP in 2030 (excl. industry).	The reduced electricity demand (10 PJ) is adjusted in the same way as scenario B. The reduction in heat production from CHP is adjusted by increasing the share of district heat production from boilers and heat pumps.
E) Switch of heat supply technology, increased use of individual heat pumps	The share of each heat production technology is adjusted according to data from the \`EU energy trends to 2030 – Update 2009´.	Scenario E The heat supply from individual heat pumps for district heating is increased by 10 %, in the residential and tertiary sector, compared to the reference scenario. The supply from boilers and electric heaters is reduced accordingly.	The reduced electricity demand (22 PJ) is adjusted in the same way as scenario B. The reduction in heat production from CHP is adjusted by increasing the share of district heat production from boilers and heat pumps.
F) Switch of electricity supply technology	The share of each electricity production technology is adjusted according to data from the \`EU energy trends to 2030 – Update 2009´ (e.g. 145 PJ increase in wind power production).	Scenario F The generation from wind power is increased by an extra 72 PJ (20 TWh) compared to the reference scenario.	The surplus electricity production is adjusted as for the other instruments by increasing the export of electricity with 25 PJ and reducing the production from thermal plants with 36 PJ. The deficit heat supply is covered by increasing the heat pump share which again increases the electricity demand.

Table 15: Overview of scenario assumptions.

The effect of the different policy scenarios on primary and final energy consumption compared to the reference scenario is presented in Figure 33 including additional net import of electricity compared to the reference. For more detail on each modelled scenario, see Annex 1.

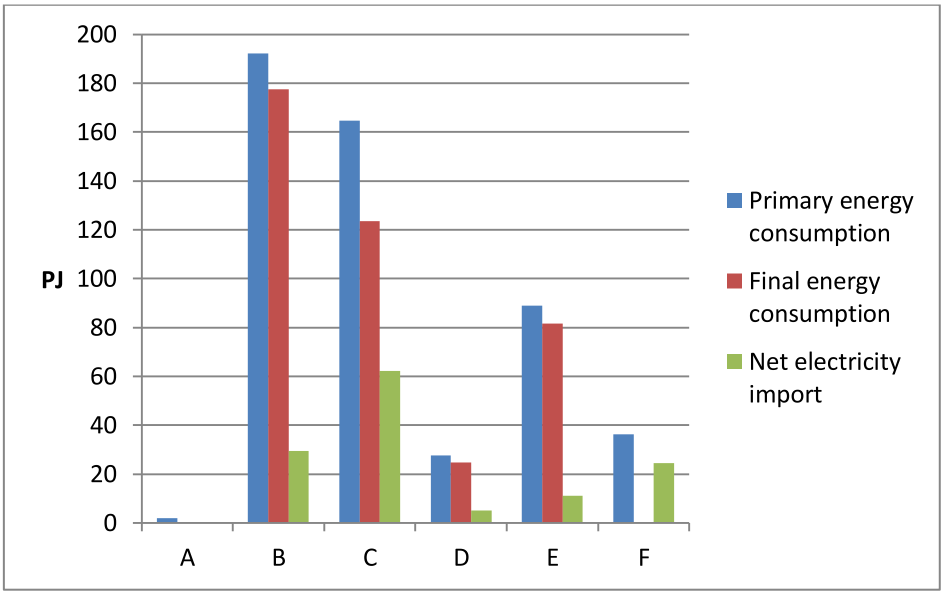

Figure 33: Reduction in primary and final energy consumption and additional electricity import ('net electricity import') in 2030 in scenario A, B, C, D, E and F compared to the reference scenario. The scenarios are: A) Share of CHP; B) Building insulation; C) Efficiency of lighting and other electric appliances; D) Boiler and heat pump efficiency; E) Switch of heat supply technology, increased use of individual heat pumps; F) Switch of electricity supply technology.

The figure illustrates the differences in the instruments' effect on primary and final energy consumption respectively. The additional net import of electricity can potentially be added to both primary and final consumption to show the effect of each instrument with no additional electricity export. It is important to underline that the scale of the effect is of less interest to the analyses as they depend on the scenario assumptions.

The moderate result of scenario A (CHP) can be explained by the current high share CHP currently in the Nordic system.

It is visible that for scenario B, D and E, which cover increased building insulation, increased efficiency for individual heat boilers and individual heat pumps, and switch of individual heat supply technology to heat pumps, that the impact of each instrument is similar for both primary and final consumption.

For scenario C, which covers increased efficiency of electric appliances, the effect is larger in primary energy than in final energy, due to efficiency losses in the conversion to electricity.

For scenario A and F, covering increased share of CHP and switch of electricity supply technology, the instruments only effect the consumption of primary energy.

Fuel mix

Looking at the total consumption by type of fuel the difference between the six scenarios is not large. However, there are significant differences between the scenarios when comparing the composition of the primary consumption by energy source to the reference. Figure 34 below shows that scenario B, C, E, and F are quite different. In scenario F increase in wind power generation reduces primary energy consumption significantly.

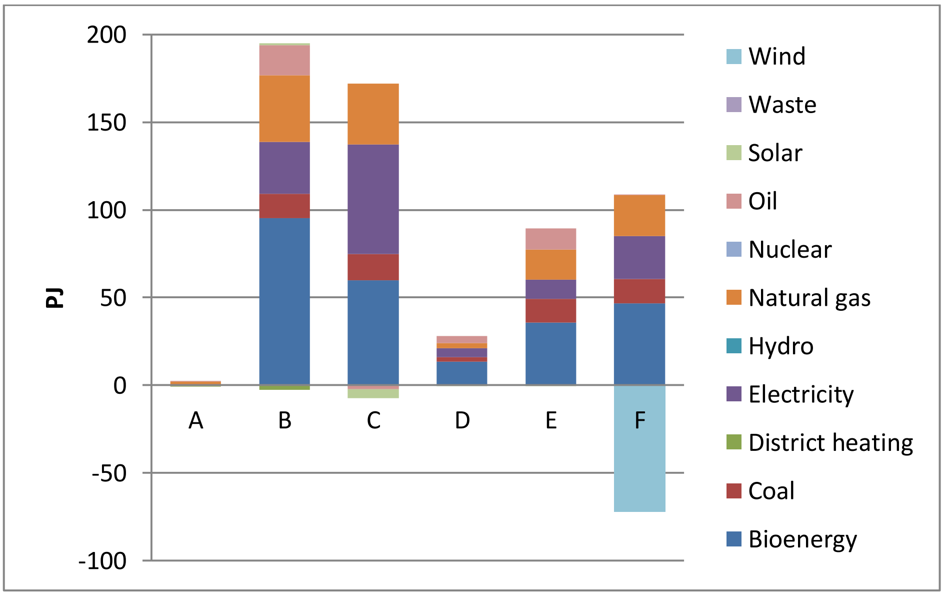

*Figure 34: Change in **primary** energy consumption by type of energy (including refinery). The scenarios are: A) Share of CHP; B) Building insulation; C) Efficiency of lighting and other electric appliances; D) Boiler and heat pump efficiency; E) Switch of heat supply technology, increased use of individual heat pumps; F) Switch of electricity supply technology.*

Similarly, there are significant differences between the scenarios when comparing their final consumption by energy source to the reference. The graph below shows that scenario B (building insulation) impacts solar, oil, and bioenergy consumption to the same extent as scenario E (switch from individual heat pumps to district heating).

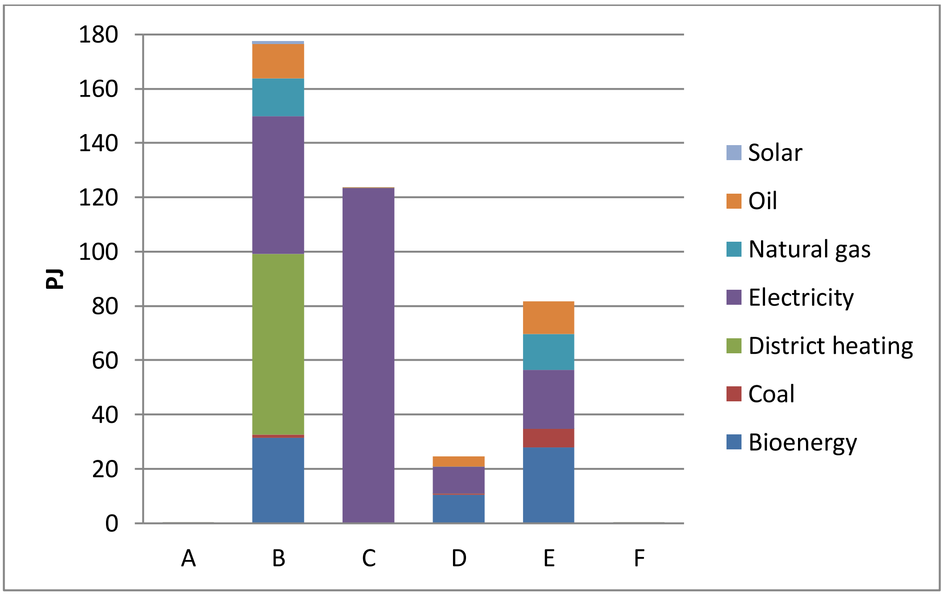

*Figure 35: Change in **final** energy consumption by type of energy relative to the reference scenario.*

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Annex 1 – Detailed scenario results

Results of the six modelled policy instrument scenarios are presented one by one in the following.

Scenario A – Increased share of CHP

The 5 % reduction in the share of electricity only in the production from thermal plants in the scenario A compared to reference leads to a 2.4 PJ increase in heat production from CHP units. This is due to reduced heat only production from coal, oil and natural gas boilers. Scenario A leads to a total reduction of 1.9 PJ in primary energy consumption compared to the reference. An effect will only occur in primary energy consumption – the final energy consumption remains unchanged.

The effect on primary energy demand for heat production is illustrated in Figure 36.

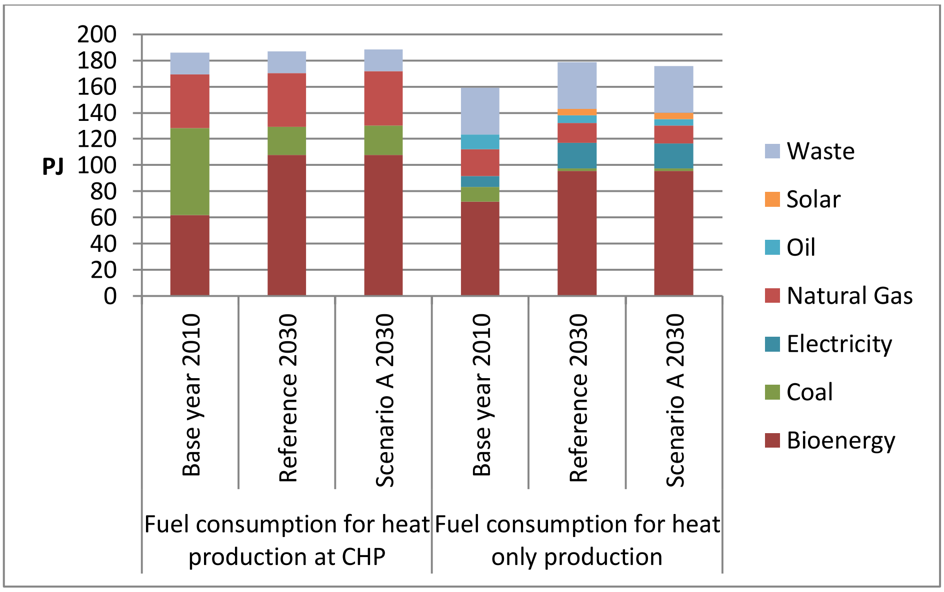

Figure 36: Primary energy consumption for heat production in Scenario A.

The share of power produced on CHP plants is already high in the reference scenario, making the potential for increased CHP limited. This is reflecting a situation today where the share of CHP is already relatively high compared to other countries and region, and where there is a political focus on realising the full potential in the coming years. Scenario A is illustrates a development where 95 % of all power will be from CHP plants. In practice this requires that it is possible to dispose of the produced heat, even in the summer months when the demand is low, or that CHP plants are not used for heat production in the summer months, which can be an expensive solution.

Scenario B – Improved building insulation

In Scenario B the heating losses in buildings is reduced by increasing the energy savings targeted heat consumption from 15 % in reference to 30 % for the period 2010 to 2030 in the residential and tertiary sector. The increased energy savings in buildings lead to a 178 PJ reduction in final consumption in heat supply in the residential and tertiary sector. The effect is illustrated in Figure 37.

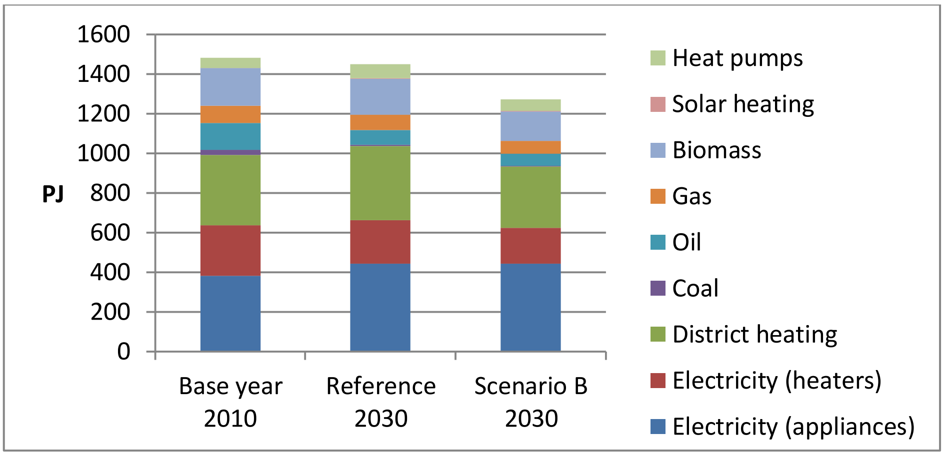

Figure 37: Final energy consumption in residential and service sector in Scenario B (heat pumps are calculated as electricity input).

The lower heat demand is adjusted in the model by reducing the electricity production from thermal power plants (both fossil and biomass) and reducing the heat production from both boilers (both fossil and biomass) and heat pumps.

An effect can also be measured in the total primary energy consumption. The primary energy consumption is reduced by 192 PJ compared to the reference scenario (see Figure 38).

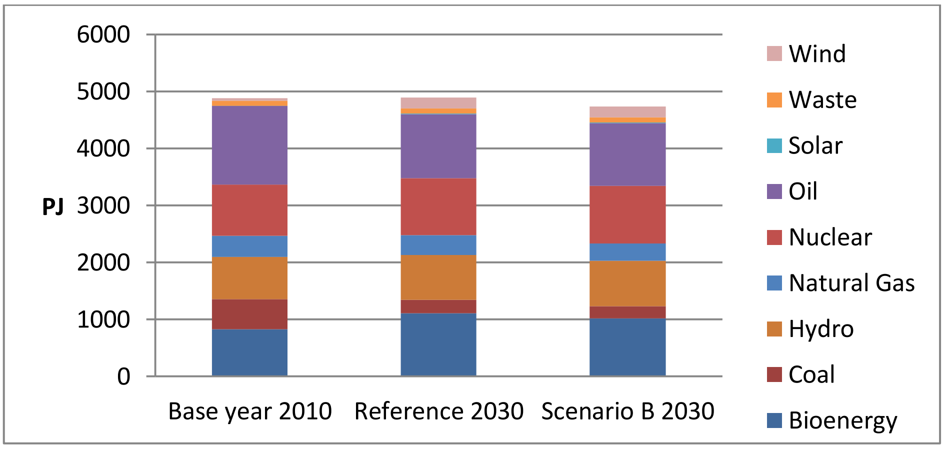

Figure 38: Total primary energy consumption in Scenario B (excluding net import of electricity).

Scenario C – Improved efficiency of lighting and other electric appliances

In scenario C energy savings for electric appliances for the period 2010 to 2030 is increased to 25 % in the residential and tertiary sector and to 37 % savings in industry. This leads to a total reduction in electricity demand of 125 PJ. The lower electricity demand is adjusted in the model by increasing the export of electricity with 62 PJ (50 % of the reduction in electricity demand) and reducing the electricity production from thermal power plants (both fossil and biomass) with 62 PJ, leading to a 69 PJ reduction in heat supply from CHP. To cover the heat demand, the supply from heat only production is increased for boilers (fossil and biomass), solar heating and heat pumps. The effect on final energy consumption in the residential, tertiary, industry and transport sector is illustrated in Figure 39.

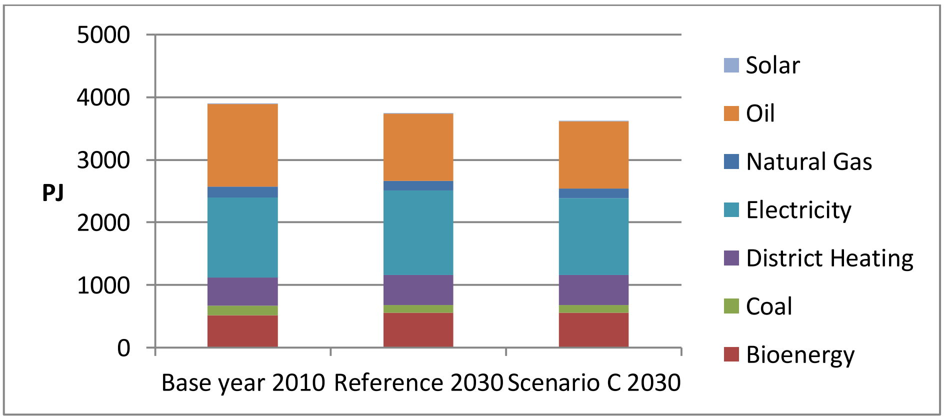

Figure 39: Final energy consumption in residential, tertiary, industry and transport in Scenario C.

Lower electricity consumption due to savings at end-user level will both affect final and primary energy consumption. The effect on primary energy consumption is a saving of 165 PJ, and an increase in electricity export.

Scenario D – Improved boiler efficiency and heat pumps

The efficiency of all boilers for heat production in the residential and tertiary sector is increased by 5 % in scenario D compared to the reference. Heat pump efficiency is increased from 3.0 COP in the reference to 3.5 COP (excluding industry). This leads to a reduction in final energy consumption in the residential and tertiary sector of 25 PJ, shown in Figure 40. The effect is both visible in final and primary energy consumption. In primary energy consumption the improvement leads to a 28 PJ reduction.

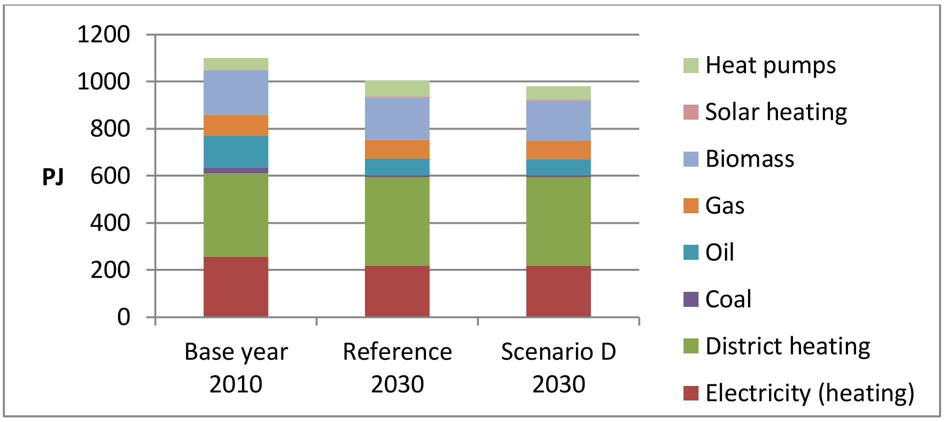

Figure 40: Final energy consumption for heat in the residential and tertiary sector in Scenario D (heat pumps are calculated as electricity input).

Scenario E – Change of heat supply – increased share of heat pumps

The share of heat supply from individual heat pumps in the residential and tertiary sector is increased with 10 % (approximately 36 PJ increase in electricity input). The effect on final energy consumption for heat in the residential and tertiary sector is illustrated in Figure 41.

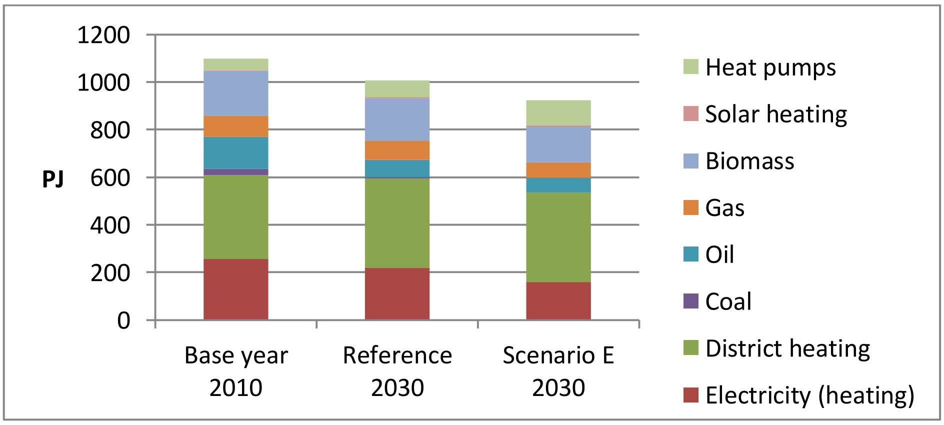

Figure 41: Final energy consumption for heat in the residential and tertiary sector in Scenario E (heat pumps are calculated as electricity input).

Because of the high efficiency for heat pumps the final energy demand is reduced by 82 PJ compared to the reference scenario.

Total final energy consumption (all sectors including the transport sector) is reduced by 89 PJ compared to reference.

Scenario F – Switch of electricity supply technology

The share of wind power is increased by 20 TWh (72 PJ) compared to the reference. The increased production is shared between onshore (54 PJ increase) and offshore wind power (18 PJ increase). The rest of the electricity production is adjusted by reducing the production from thermal plants with 36 PJ leading to a 40 PJ reduction in heat supply from CHP. The surplus heat demand is instead covered by heat pumps which again increase the total electricity demand and also ensure flexibility in the energy system. The surplus electricity export compared to the reference scenario amount to 25 PJ. The effect is only visible in primary energy consumption where the total primary consumption is reduced by 36 PJ (excluding export) as illustrated in Figure 42.

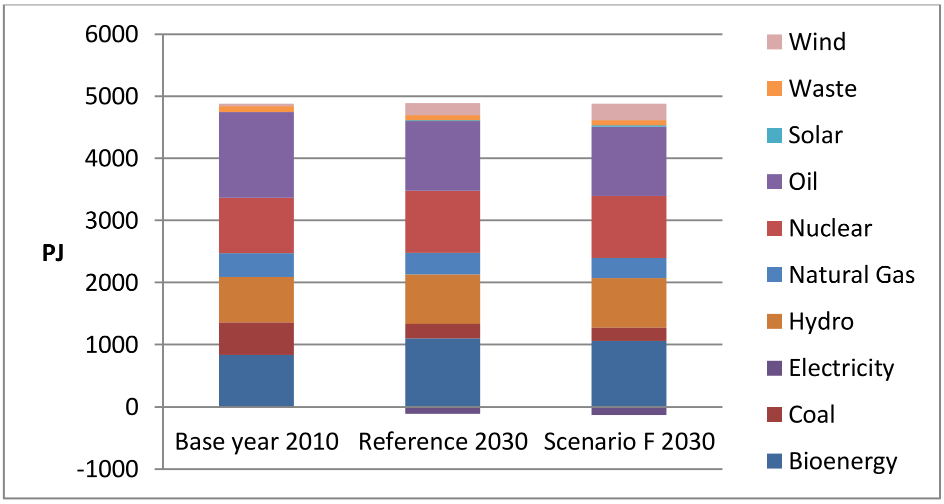

Figure 42: Primary energy consumption (including net import of electricity) for all sectors in Scenario F.

All scenarios relative to the reference

Looking at the total consumption by type of fuel it is clear that the analysed policy instruments only have a moderate impact on the total consumption level and the shift in energy types.

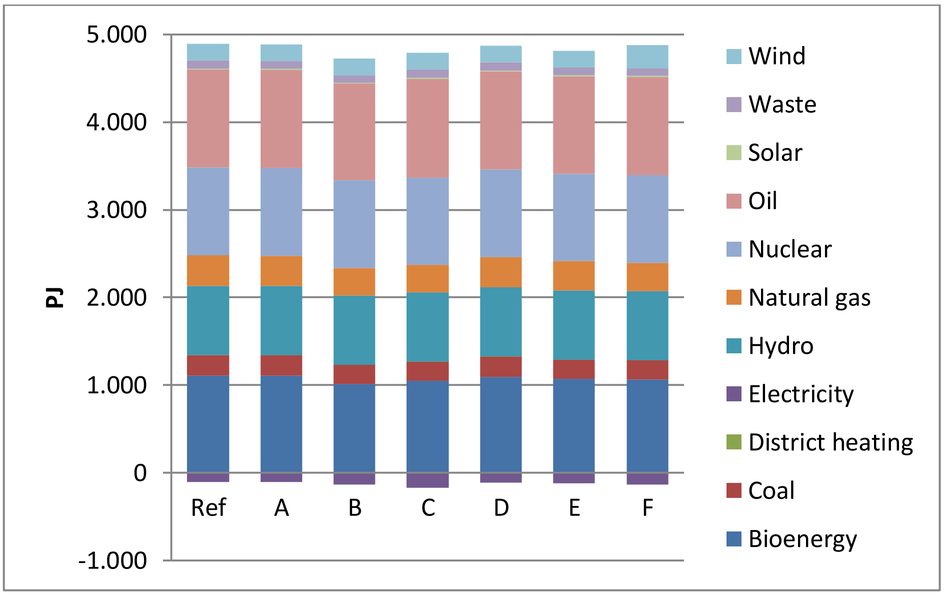

Figure 43: Primary energy consumption by type of energy (including refinery).

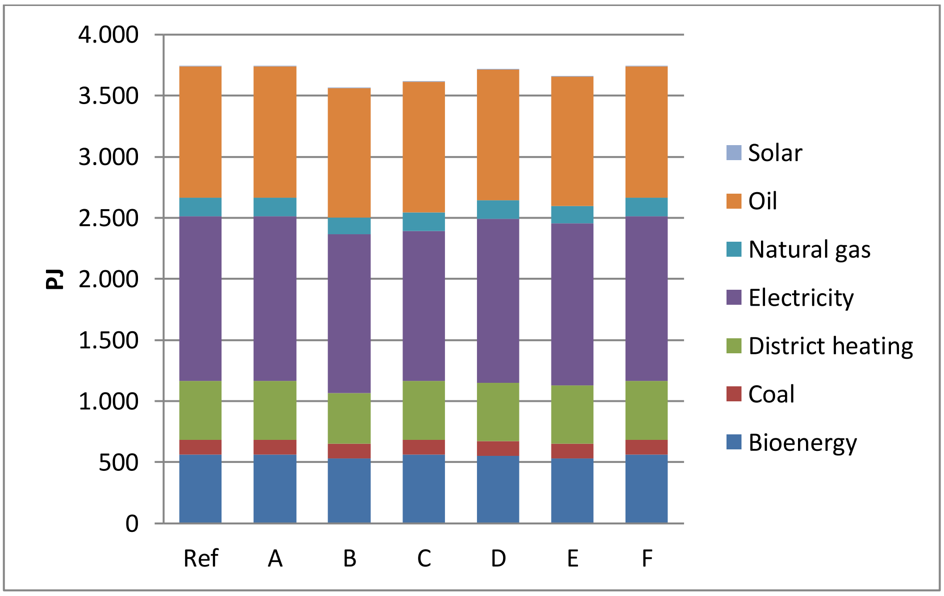

Figure 44: Final energy consumption by type of energy.