Final report

Nordic Energy Perspectives

Draft version, including parts still in Scandinavian languages

Widened view of energy efficiency and resource management

Including some results from the MARKAL model

March, 2009

Nordic Energy Perspectives

Preface

Nordic Energy Perspectives (NEP) is an interdisciplinary Nordic energy research project with the overall goal of demonstrating means for stronger and sustainable growth and development in the Nordic countries.

NEP analyses the national and international political goals, directives, and policy instruments within the energy area, as well as their influence on the Nordic energy markets and energy systems and the infrastructures and institutional structures. NEP aims at clarifying to decision-makers the consequences of political and strategic decisions for politicians, energy actors and the public. The project is to promote a constructive dialogue among researchers, politicians, authorities and actors on the energy markets. For further information about the project, please visit: *www.nordicenergyperspectives.org*.

This series of reports are the second reporting from the second phase of the project. The following intermediate and final reports are now presented:

<u>Synthesis report, March 2009:</u>

- Second NEP2 synthesis report *(Responsible: Peter Fritz, Håkan Sköldberg, Bo Rydén)*

<u>Final reports, March 2009:</u>

- Widened view of energy efficiency... *(Responsible: Bo Rydén)*
- Technology options for a low CO_2 energy system *(Responsible: Tiina Koljonen)*
- Wood markets and the situation of the forest industry in the Nordic countries *(Responsible: Per Erik Springfeldt)*

<u>Intermediate reports, March 2009:</u>

- Reference and policy scenarios *(Responsible: The NEP model group)*
- Global scenarios *(Responsible: Janne Niemi)*
- Biomass market and potentials *(Responsible: Tiina Koljonen)*
- Nordic perspectives on the EU goals relating to CO_2, renewable energy and energy efficiency *(Responsible: Thomas Unger, Bo Rydén)*
- Prominent strategies for environmental sustainability in the stationary energy sector *(Responsible: Anders Sandoff)*
- The future of the Nordic district heating *(Responsible: Monica Havskjold, Håkan Sköldberg)*
- Trade within the RES directive and related power interconnection issues *(Responsible: Berit Tennbakk)*
- Natural gas in the Nordic countries *(Responsible: Peter Fritz)*

Our intention in NEP is to present all reports in English. Due to lack of time, some of the texts in some of the reports are at this stage still in Scandinavian languages. We apologize for this. These texts will as soon as possible be translated into English. The translated texts/reports will be available on the project's web site, *www.nordicenergyperspectives.org*, soon after the Oslo conference.

Oslo, March 2009

The NEP Research Group

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Observera:
Energieffektivisering inom transportsektorn hanteras endast översiktligt i denna rapport. I NEP-rapporten “Nordic perspectives on the EU goals relating to CO2, renewable energy and energy efficiency” (appendix), görs en utförligare genomgång av effektiviseringsåtgärder och potential i transportsektorn i Norden.

Läsanvisning

Denna rapport är en första del av ”slutrapporten” om effektivisering i NEP. Under våren 2010 kommer en andra del.

Denna första del omfattar följande avsnitt:

1. En introduktion om hur vi ser på begreppet energieffektivisering och vad vi inkluderar i definitionen av det.
2. Alla nordiska länder har en energipolitik som, direkt och indirekt, ger incitament för energieffektivisering. I det andra avsnittet ges några exempel på hur stor energieffektivisering denna lett till i några nordiska länder och sektorer.
3. EU:s ESD-direktiv om 9% energieffektivisering till 2016 beskrivs kortfattat i nästa avsnitt.
4. Avsnitt 4 ger en kort beskrivning av de nationella planer (NEEAPs) som Finland, Danmark och Sverige lämnat till EU i enlighet med direktivet.
5. I avsnitt 5 gör vi en uppskattning/beräkning av effektiviseringspotentialen i slutanvändarledet (final energi) i de nordiska länderna, bl.a. baserat på de NEEAPs som lämnats till EU inom ESD-direktivet, men också med andra offentliga rapporteringar i länderna (bl.a från Enova för Norge).
6. I följande avsnitt diskuteras hur stor del av effektiviseringspotentialen som kan vara samhällsekonomiskt motiverat att realisera. Diskussionen är hämtad från Eneff – utredningen, som utgjort grunden för det svenska NEEAP-arbetet, och har fokus på bostads- och servicesektorn i Sverige.
7. Styrmedel blir nödvändiga för att kunna realisera vår effektiviseringspotential. I avsnittet görs också en kort genomgång av styrmedel som diskuterats i det svenska NEEAP-arbetet.
8. Förutom ESD-direktivet har EU en målsättning om 20% effektivisering till 2020; en målsättning som kan komma att inkluderas i EUs energi- och klimatpaket under 2009. I en PM publicerad under 2008 ger EU-kommissionen förutsättningarna för detta 20%:s mål. Ett kort utdrag ur denna PM återfinns i avsnitt 7. Slutsatsen i PM:n är att ett tydligt mål om 20% effektivisering behövs.
9. Slutsatsen från NEPs beräkningar av potentialen i avsnitt 5 är att det finns potential, stor nog för att kunna bidra till att ett mål om 20% energieffektivisering nås (räknat som primärenergireduktion från en ”business-as-usual”-nivå år 2020). Vår bedömning är att åtminstone hälften av åtgärderna måste vara åtgärder som faktiskt reducerar den slutliga energiförbrukningen (useful energy). Den andra hälften av åtgärder återfinns i energiomvandlingsleden, både storskalig (t.ex. elproduktion) och småskalig (t.ex. uppvärmning i bostäder).
10. Med MARKAL-modellen gör vi beräkningarna i NEP av hur ett 20%:s-mål påverkar utvecklingen av det nordiska energisystemet och de två andra 20%-målen (CO2 och förnybart).
11. I avsnitt 8-9 visar vi resultaten från dessa beräkningar och redogör också för hur de antaganden vi gjort för att uppnå 20% effektivisering (räknat som primärenergireduktion från en ”business-as-usual”-nivå år 2020).
12. Energieffektivisering inom transportsektorn hanteras endast översiktligt i denna rapport. I NEP-rapporten “Nordic perspectives on the EU goals relating to CO2, renewable energy and energy efficiency” görs en utförligare genomgång av effektiviseringsåtgärder och potential i transportsektorn i Norden.

1. What is “energy efficiency”?

The discussion in this section has its starting point at the end user. Then the perspective is widened to the entire energy system.

The ESD directive’s definitions

The EG directive on effective end use of energy and on energy services[1] has these definitions in Article 3:

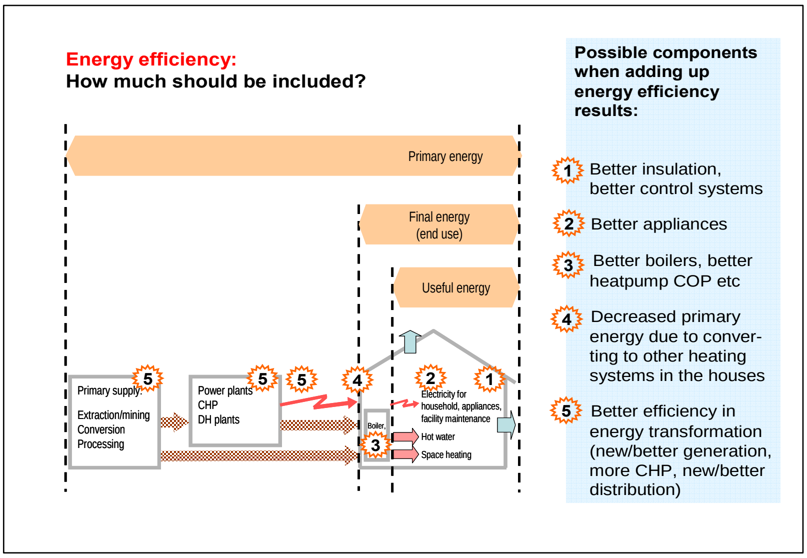
- *Energy effectiveness:* The relationship between the production of performance, services, goods or energy and the input of energy.
- *Improved energy effectiveness:* Increase of effective end use of energy because of technical, behavioral and/or economic changes.

(See more about the ESD directive in chapter 3 below.)

How much energy should we reckon with? Where are the system boundaries?

When we count in energy terms, it is the *delivered (purchased) energy* that is counted (“final energy”). But this is not always an adequate method – for a pellet boiler the conversion losses are included, and for an electrically heated house they have already been taken before delivery to the end user.

We can change to calculating with *primary energy*. This is intended to reflect all energy which is used, from the fuel source (or equivalent) to the end user.



The concepts of primary energy, final energy use and useful energy.

Different measures in different parts of the energy system

Primary energy should include all energy losses in the paths that precede the final use. The different national action plans on implementation of the ESD directive has produced weights for all kinds of energy in the end-user path, and calculates consistently in terms of both final use and primary energy.

[1] Often abbreviated as the ESD directive, also called the “energy service directive” in Sweden. The Swedish inquiry concerning its implementation is termed EnEff, the Energy Efficiency Inquiry.

How weights should be assigned is not obvious. In certain cases, such as oil, it becomes clear that all energy use connected with extraction, refining, transports etc. must be included. But how do we regard the primary energy input for electricity production? What production is used to produce the used electricity? What system boundaries should be used? Should the marginal or average view be applied? Should a factor of 3 to electricity from nuclear power plants be used? Is this a good reflection of the evaluation we want to make of the resource consumption by different kinds of energy? As the following section shows, the choices of weights have a large influence when one seeks a way of attaining overall energy and climate targets. In other parts of the NEP project we also discuss the alternative to *count primary energy only for non-renewable energy.*

The last-mentioned is stated as a possibility in the CEN standard (prEN 15217) for buildings' energy performance. Four alternatives are given:

- Weighted delivered energy (the weights may be defined according to national policy)
- Primary energy (in this report, this alternative is used)
- CO2 emissions
- Energy cost

These alternatives illustrate very well some basic possibilities that we have of finding usable ways to count the energy which is used, and to do it so that the "whole energy system" is included. Yet however cleverly such a way of counting is designed, it can never give "the full answer to the question", but must be considered together with other factors and together with other targets.

The components of energy efficiency

In order to analyze and evaluate energy efficiency, we almost always need to analyze its components – what part of the changed energy use is due to "genuine energy efficiency", how much of it is due to introduced policy instruments, how much is due to changes in population size, better housing standards, changed industrial production, etc. At the present stage, this issue is only roughly sketched with the help of a fundamental picture from the EU document on the 20% target for energy efficiency:

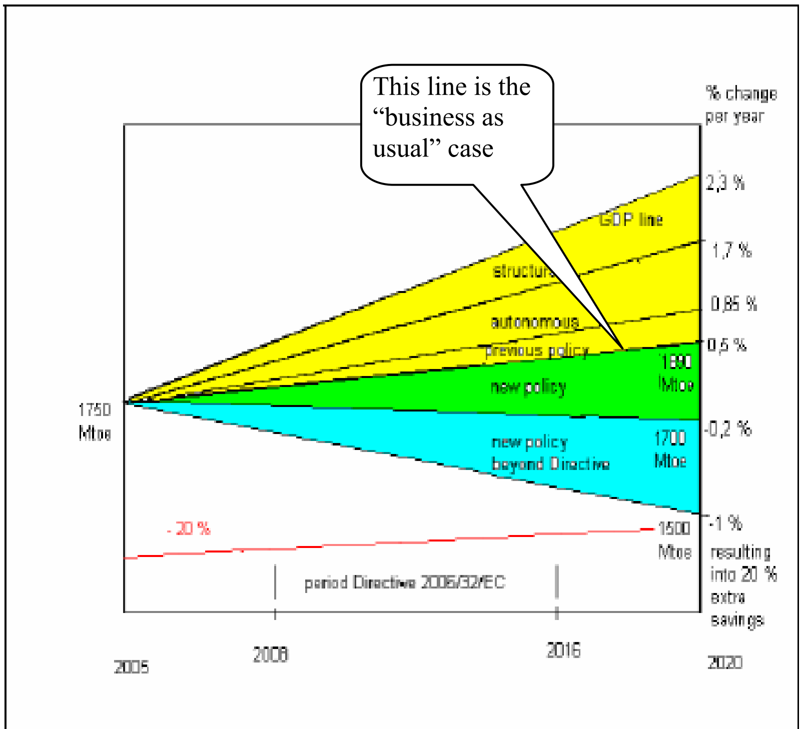


Figure 3: Annual improvements in energy intensity [13]

The change in energy use compared with a prognosis solely according to total GNP trends can be divided into:

- "Structural", e.g. changed composition of industrial production

- "Autonomous", through exchange of apparatus that takes advantage of technical development

- "Previous policy", future influence of already introduced policy instruments

- "New policy", introduction of new policy instruments to achieve efficiency targets

2. Illustrative examples of energy efficiency in the Nordic countries as a consequence of historical policies

All Nordic countries have existing energy policies that, directly or indirectly, give incentives for improved energy efficiency. In this section we provide some examples of how large improvements in energy efficiency that these policies have resulted in for some Nordic countries and user sectors.

2.1 Energy saving activities in Finland

The first separate programme for energy efficiency was launched in 1992 and the programme has been renewed on a regular basis (1995, 2000, 2002). The Action Plan for Energy Efficiency defined energy efficiency measures for the period 2003–2006, but the target year for energy efficiency improvements was 2010. In 2005, this Action Plan was incorporated into Finland´s new National Energy and Climate Strategy. The target, defined in the strategy, was to achieve an additional 5 % energy savings by 2015 by intensifying existing measures and by introducing new measures connected to the implementation of EU directives.[2]

Energy saving activities in the Finnish industry

Finnish industries started to sign voluntary energy saving agreements in November 1997. In the end of 2006 189 companies were with this agreement covering 80% (38.5 TWh) of the total energy use (47.95 TWh) of the industry.

Yearly electricity savings varied during the period 1998-2006 being at maximum 0.3 TWh/a in 2000. The total cumulative energy savings reported during 1998-2006 were 5.2 TWh for heat and fuel and 1 TWh for electricity. Without energy saving projects these companies would have 4.3% higher heat and fuel consumption and 2.6% higher electricity consumption in 2006.

The total investment cost for these energy savings was 295 M€. The Ministry of Trade and Industry of Finland (nowadays the Ministry of Employment and Economy) supported energy saving analysis of the industrial sector with 7.91 M€ and the investment support during 1998-2006 was 14.4 million euros for the 153 energy saving projects. Special interest was shown on pumping efficiency, compressed air systems, the use of high efficiency motors and increase of renewable energy use.

[2] **Reference list: Energy efficiency activities in Finland:**

Hyytiä, H. Teollisuuden energiasäästösopimuksen vuosiraportti 2006. Motiva Oy. Marraskuu 2007. In Finnish. Internet online: http://www.motiva.fi/midcom-serveattachmentguid-0deeef159729b1af9830c450838d6018/tess_vuosiraportti_2006_.pdf.

Tasa, A., Jalo, T., Isohella, R. ”Asuinkiinteistön energiansäästösopimuksen vuosiraportti 2007”. Motiva Oy. Report in Finnish, 2008. Internet online: http://www.motiva.fi/midcom-serveattachmentguid-1b549381549c1b8dabcf6d5e27ee41b0/aess_vr07_-raportti.pdf

Pihala, H., Hänninen, S., Kuoppamäki, R. Sähkönsäästöpotentiaali energiatehokkailla sähkömoottorikäytöillä Suomen energiavaltaisessa teollisuudessa. VTT-R-08216-08. In Finnish.

Figure: Finnish national voluntary energy saving program. Costs of energy projects (M€) and energy savings (TWh) for Finnish industry in 1998 - 2006.

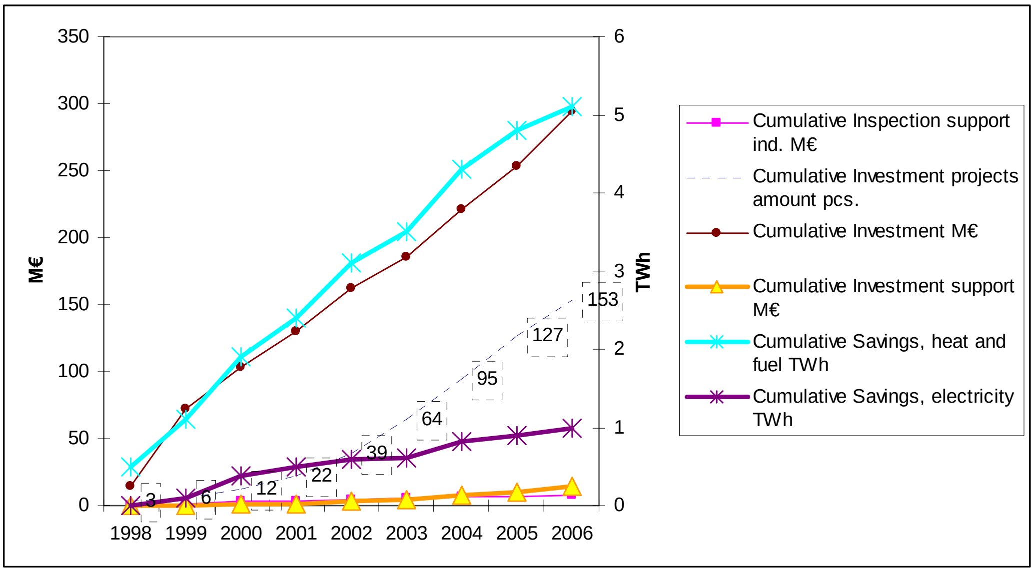


Figure: Finnish national voluntary energy saving program. Energy projects and cumulative figures of energy savings in industry in 1998–2006.

Energy saving activities in the Finnish residential building sector

Finland has had a voluntary energy audit programme for residential buildings since 2002 and for other building types and sectors since 1992. At the end of 2007, more than 6,800 buildings used for manufacturing and service production were covered by auditing activities. The annual impact on energy conservation is estimated at approximately 1 TWh. The Ministry of Em-ployment and the Economy will continue this work, which was launched by the Ministry of Trade and Industry.

The voluntary energy saving agreement for residential buildings was signed in November 2002 for the 2002-2010 period.

In the end of 2007 28 communities (11.3 Mm^2 of total 260 Mm^2 in Finland) had signed the agreement. Nominal energy consumption has varied during the period but generally nominal heat consumption decreased 1.9-3.7% and nominal electricity (for building estates) consumption decreased 25.3-38% between 2003-2008 (see figure below). Also water consumption per person decreased 8.2-9.2% and water consumption was around 20-25% smaller in the houses, which were equipped with separate meters for each apartment compared to the houses without separate meters. However, because of the remarkable changes in the participating communities yearly numbers are not totally comparable.

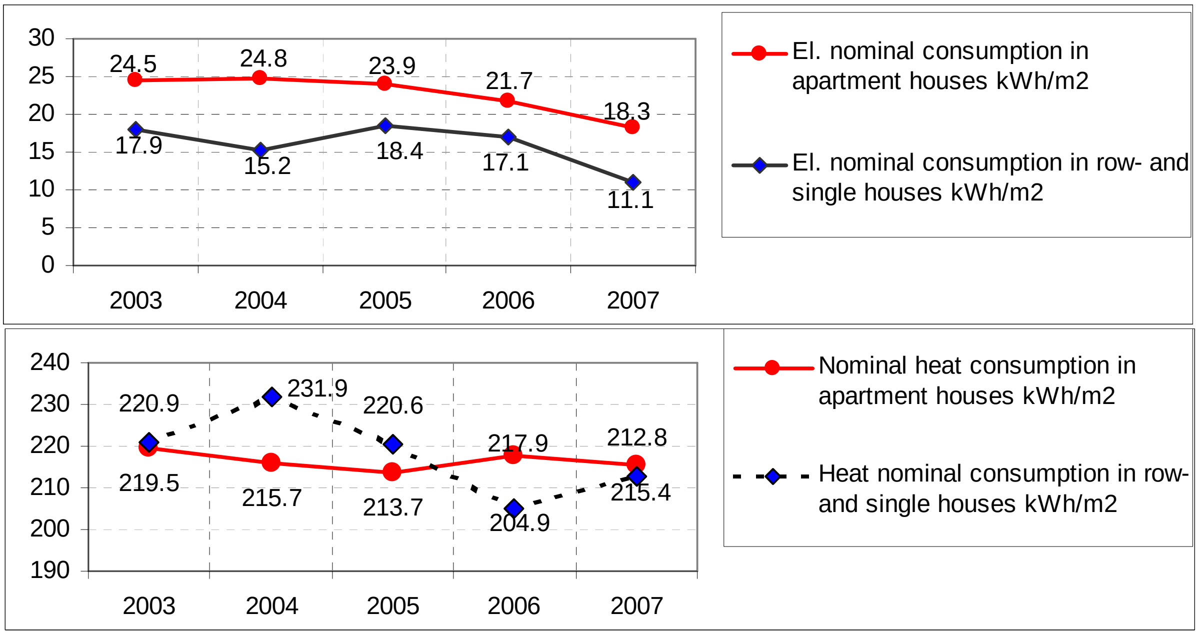


Figure: Development of the heat and electricity use in the residential buildings during the energy saving agreement period 2003-2007.

Energy analysis was supported by ~3.1 M€ for 2838 targets and 125296 apartments being at maximum 50% of the total analysis cost of a separate target.

2.2 Sverige – effektivisering i bostäder och lokaler 1995–2004

Avsnittet omfattar beräkningar för bostäder och lokaler. De bostäder och lokaler som ingår definieras så här:

Småhus: Permanentbebodda småhus (bostad för 1 eller 2 familjer) inklusive småhus på jordbruksfastighet. Permanentbebodda definieras så som SCB gör i sin energistatistik, dvs det är småhus med någon folkbokförd.

Flerbostadshus: Byggnader med bostäder åt minst tre familjer, där bostadsarean är större än eventuell lokalarea.

Lokalbyggnad: Byggnader för kommersiella eller offentliga verksamheter såsom kontor, butiker, hotell, vård, undervisning, fritidsaktiviteter, kultur med mera, där lokalarean är större än eventuell bostadsarea. - Byggnader som fastighetstaxeras som industri ingår inte i ”lokalbyggnader”.

Beräkningarna avser värmeåtgärder som skett i bostäder och lokaler. Den energi som beräknas för bostäder och lokaler i denna utredning är således enbart energin för uppvärmning och varmvattenvärmning. Följande behandlas ej: Hushållsel, el för fastighetsdrift, verksamhetsel, energi för kylning.

Sammanfattningsvis har energianvändningen för uppvärmning och tappvarmvatten minskat på följande sätt för den kvarstående bebyggelsen från 1995:

Förändringar i kedjan primärenergi – nettovärme från 1995 till 2004. Basfall

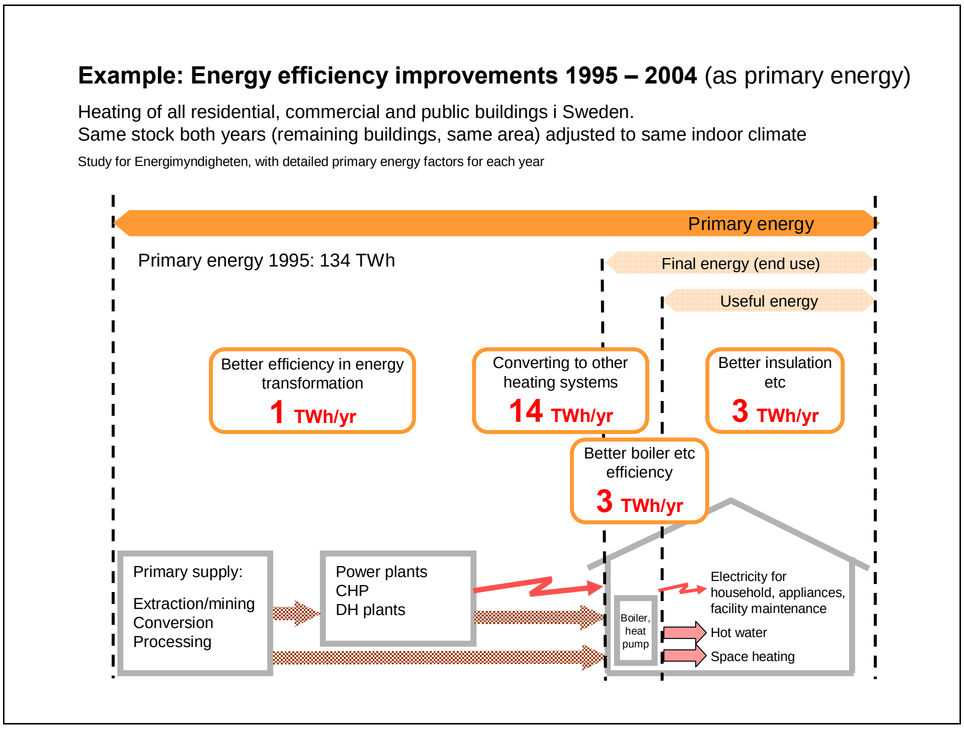
	Primärenergi GWh	Levererad energi, GWh	Nettovärme, GWh	Total primär-energifaktor
1995				
Småhus	75 780	43 218	34 786	2,18
Flerbostadshus	37 936	31 211	29 998	1,26
Lokalbyggnader	36 124	25 062	23 818	1,52
SUMMA	149 841	99 491	88 602	1,69
2004				
Småhus	67 686	37 722	35 144	1,93
Flerbostadshus	36 415	29 820	30 685	1,19
Lokalbyggnader	29 259	20 554	21 785	1,34
SUMMA	133 360	88 095	87 615	1,52
Ändring 1995-2004	-16 480	-11 396	-987	-0,17
Ändring %	-11,0%	-11,5%	-1,1%	-10,0%

Primärenergianvändningen beräknas totalt ha minskat med 16,5 TWh/år, en minskning med 11%. Nettovärmen har minskat men bara obetydligt, så minskningen beror framförallt på minskade förluster i hela kedjan från energikälla till radiator, samt på konverteringar som normalt går till uppvärmningssätt med bättre primärenergifaktorer. En stor ökning av värmepumpar är en viktig förklaring. Minskningens fördelning på olika komponenter ser ut så här:

Primärenergins förändringar 1995 – 2004 fördelade på olika komponenter, TWh

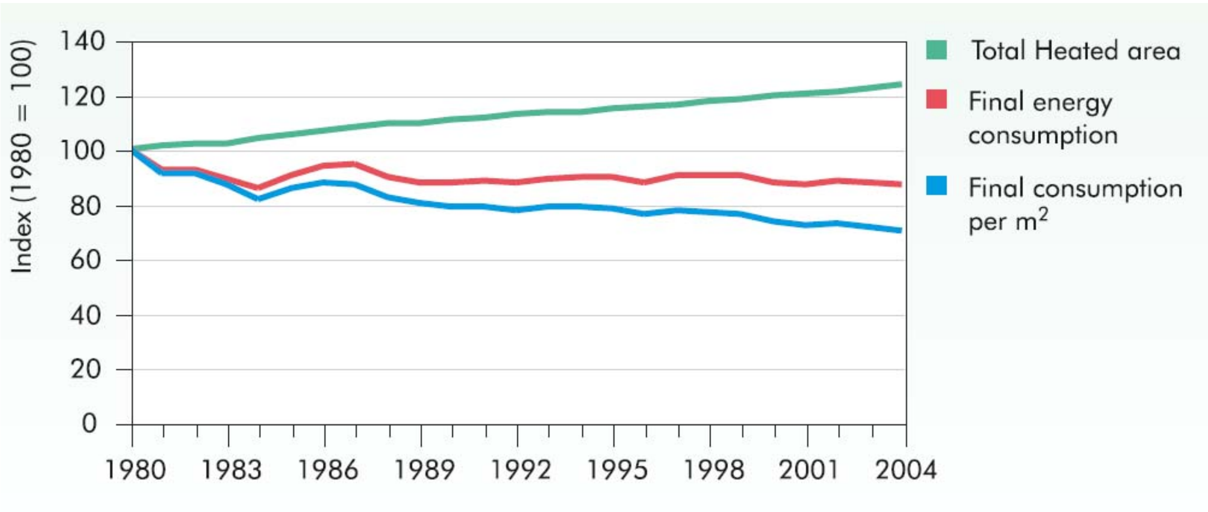
	Små-hus	Flerbo-stads-hus	Lokal-bygg-nader	**Sum-ma**	
Förändring av husens värme-behov netto	+0,8	+0,9	-3,0	**-1,3**	TWh primärenergi
Konverteringar exklusive för-bättringar av pe-faktorer	-7,2	-2,5	-3,8	**-13,5**	TWh primärenergi
Ändrade verkningsgrader i hu-sen, pe20	-1,7	-0,4	-0,5	**-2,6**	TWh primärenergi
Ändrade verkningsgrader i ut-vinning-prod-distr, pe52	+0,1	+0,6	0,3	**+1,0**	TWh primärenergi
Summa minskad primärenergi 1995 -2004	-8,1	-1,5	-6,9	**-16,5**	TWh primärenergi

Tabellen illustrerar att själva konverteringarna är den helt dominerande orsaken till att primärenergin minskat. Bättre verkningsgrader i olika panntyper och bättre värmefaktorer i värmepumpar bidrar också men mer måttligt.



2.3 Housing insulation in Denmark

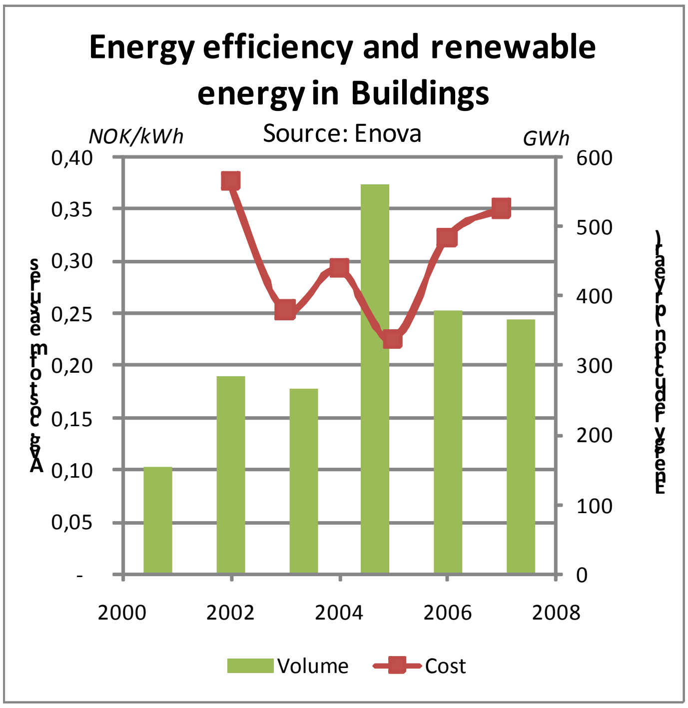
Denmark has had a strong policy for improved insulation and the general energy efficiency of housing since the 1970s. As a result, the overall final consumption for space heating in the residential sector has been declining even though the amount of heated area has been growing. Adjusted for climate, the energy consumption for space heating per square meter in all the existing building stock is only 70% of the consumption in 1980 (Figure below). At the same time, the comfort level has been increasing.



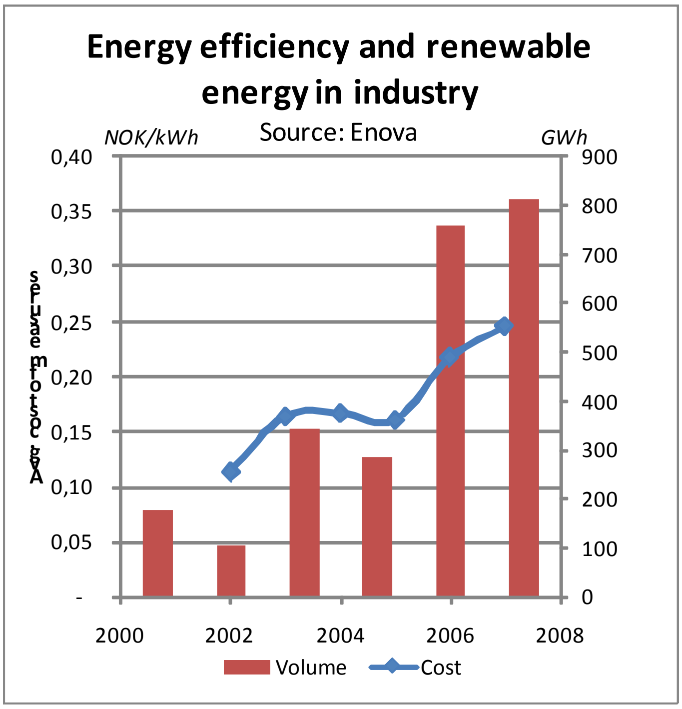
Source: IEA ETP 2006

2.4 Totala förändringar i bostäder och industri i Norge 2002-2007

Det finnes lite offentlig tilgjengelig statistikk som kan indikere energieffektivisering i et top-down perspektiv (aggregert). For Norge har vi derfor tatt utgangspunkt i resultatene som er oppnådd av Enova som er myndighetenes viktigste virkemiddel for å oppnå økt energieffektivisering. Resultatene blir derfor et Bottom-up perspektiv, og sier kun noe om effekten av Enovas virkemidler. Annen effektivisering er det ikke mulig å dokumentere foreløpig. Det er viktig å merke seg at både volumer og kosntader relaterer seg til resultater for energieffektivisering og omlegging til fornybar energi samlet sett, da tiltak som støttes av Enova gjerne inneholder begge typer tiltak.



Næringsbygg
For næringsbygg ble det i perioden 2002-2007 realisert tiltak for i alt 2,0 TWh. Støttekostnaden for tiltakene ligger i området 2,5-4 øre/kWh pr år.



Industri
For industri ble det i perioden 2002-2007 realisert 2,5 TWh i effektivisering og omlegging. Støttekostnaden for tiltakene er lav, i området 1,1-2,5 øre/kWh pr år.

3. The EU's ESD-directive on 9% energy efficiency to 2016

The European Union (EU) has adopted a framework for energy end-use efficiency and energy services. Among other things, this includes an indicative energy savings target of 9% to 2016 for the Member States, obligations on national public authorities as regards energy savings and energy efficient procurement and measures to promote energy efficiency and energy services.

The text below has been found on the EU's web site:
http://europa.eu/scadplus/leg/en/lvb/l27057.htm

EU Energy end-use efficiency and energy services

Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC.

SUMMARY
The purpose of the Directive is to make the end use of energy more economic and efficient by:

- establishing indicative targets, incentives and the institutional, financial and legal frameworks needed to eliminate market barriers and imperfections which prevent efficient end use of energy;
- creating the conditions for the development and promotion of a market for energy services and for the delivery of energy-saving programmes and other measures aimed at improving end-use energy efficiency.

The Directive applies to the distribution and retail sale of energy, the delivery of measures to improve end-use energy efficiency, with the exception of activities included in the greenhouse gas emissions trading scheme, and, to a certain extent, the armed forces. It targets the retail sale, supply and distribution of extensive grid-based energy carriers, such as electricity and natural gas as well as other types of energy such as district heating, heating oil, coal and lignite, forestry and agricultural energy products and transport fuels.

<u>General targets for saving energy</u>
Member States must adopt and achieve an indicative energy saving target of 9% by 2016 in the framework of a national energy efficiency action plan (NEEAP). This target has been set and calculated in accordance with the method set out in Annex I to the Directive. Member States must also set themselves an intermediate national indicative target to be achieved by 2009.

They must also appoint one or more new or existing independent public sector authorities or agencies to ensure overall monitoring of the process set up to achieve these targets.

<u>Public sector purchasing policy</u>
Member States must ensure that the public sector adopts measures to improve energy efficiency, inform the public and businesses of the measures adopted and promote the exchange of good practice. Annex VI to the Directive contains measures that the public sector can adopt, including:

- the use of financial instruments for energy savings, such as third-party financing contracts and energy performance contracts;
- the purchase of energy-efficient equipment and vehicles;
- the purchase of low-energy products.

Member States must appoint one or more new or existing organisations to carry out administrative, management and implementation duties in order to meet their obligations.

Promotion of energy end-use efficiency and energy services

Member States must ensure that energy distributors, distribution system operators and energy retail businesses that sell electricity, natural gas, heating oil and district heating:

- refrain from any activity which could hamper the supply of energy services, programmes to improve energy efficiency and other measures aimed at improving general energy efficiency;
- supply information on their final customers needed to develop and implement programmes to improve energy efficiency;
- at the discretion of the Member States, possibly using voluntary agreements or other market-based measures, offer and promote energy services to their final customers or offer and promote energy audits and/or measures to improve energy efficiency or contribute to the financial instruments for improving energy efficiency.

Member States must ensure that market operators are provided with transparent information on programmes and measures to improve energy efficiency.

Qualification, certification and accreditation schemes for suppliers of energy services may also be put in place where Member States consider this necessary.

Member States must also repeal or amend national legislative provisions and regulations which unnecessarily or disproportionately impede or restrict the use of financial instruments or other measures for making energy savings on the energy services market. Model contracts for financial instruments must be made available to interested parties.

In addition, incentives in transmission and distribution tariffs that lead to unnecessary energy consumption must be abolished.

Member States may, if they so wish, set up financing mechanisms or adopt other measures to promote more efficient end-use of energy.

They must also develop high-quality energy auditing systems for all final customers aimed at determining which measures can be taken to improve energy efficiency and which energy services it must be possible to provide and prepare for their implementation. Certification following such audits is equivalent to that obtained under the Directive on the energy performance of buildings.

Member States must also ensure that end-users are provided with competitively priced individual metering and informative billing that shows their actual energy consumption. As far as possible, bills must be based on actual energy consumption and must include, in addition to other information, the following: current actual prices and consumption, a comparison of current consumption with consumption for the previous year, contact details of bodies from which information on improving energy efficiency can be obtained. Individual meters must be installed at a competitive price wherever economically and technically feasible.

Finally, Member States must draw up reports in 2007, 2011 and 2014 on the administration and implementation of this Directive.

4. National Energy Efficiency Action Plans (NEEAP's)

In this chapter we briefly present the current state of the National Energy Efficiency Action Plans, for the Nordic countries. According to the ESD directive the first plan was to be submitted no later than June 30, 2007.

The text below showing selected parts of the NEEAPs for Finland, Denmark and Norway has been taken from the EU's web site: http://ec.europa.eu/energy/efficiency/end-use_en.htm

4.1 NEEAP – Finland

A detailed Finnish NEEAP was submitted on June 26, 2007, after being approved by the five minis-tries involved. The total 9% target is calculated to equal 17,8 TWh. Measures already in place are estimated to cover 12,7 TWh. Further actions are now underway to cover the gap. A major role is played by voluntary agreements on energy efficiency measures with the industry and with the private and public service sector as well as with the energy sector. These kinds of agreement are already made within many energy end use sectors in Finland, covering various shares of the total sector.

Introduction

Energy savings and energy efficiency have had a focal role in Finland's national energy policies for decades. As a result of separate energy conservation programmes, the work has been systematic and sustained since the early 90s. Quantitatively speaking, the promotion activities can be estimated to have increased four-fold during the last ten years or so. The establishment of the National Energy Agency, Motiva, in 1993 contributed towards making the actions more systematic. The first separate energy conservation programme was drawn up in Finland in 1992. The programmes have been reformed and updated at regular intervals. The new Government Programme (April 2007) mentions drawing up a new, more rigorous energy conservation programme by the end of 2008.

This National Energy Efficiency Action Plan of Finland, drawn up pursuant to the obligations of the Energy Services Directive (2006/32/EC), is primarily a description of the starting position. The results of already implemented actions, the so-called Early Actions, can also be counted in the 9% energy savings target of the ESD; this was the basic prerequisite that allowed all Member States to accept the same target. The savings target of the ESD is indicative, but the Member States are obliged to initiate actions aimed at achieving the target. The Member States are also under an obligation to plan new actions in case achieving the savings target using the current actions proves unlikely. A thorough survey of the current situation is necessary for evaluating the quantitative and qualitative need for new actions.

Finland's national energy conservation target of 9% totals 17.8 TWh, and achieving it must be evidenced in 2016. The ESD also requires that an interim target is set for 2010. According to the Directive, the interim target in line with the total target is 5.9 TWh. It is estimated that the actions for which the savings effect can at this stage be calculated will achieve energy savings amounting to approximately 12.7 TWh in 2016. The energy savings in 2010 are estimated at 9.2 TWh. Section 4.3 of the Action Plan also describes several actions, the savings effects of which cannot be calculated yet in the absence of applicable bases or useful methods. How large additional savings can be calculated as a result of these actions, remains to be seen.

Evaluation of the results of energy conservation actions

This section contains information of those actions that are either currently deployed in Finland or will be deployed in the future and have energy conservation effects that can be verified and measured or evaluated. Finland's national energy conservation target of 9% for 2016 equals 17,800 GWh. The 3% interim target for 2010, in line with the total target, therefore equals 5,900 GWh.

Through the actions currently known and adhering to the general framework of measuring and verifying energy savings set out in Annex IV of the ESD, the energy savings of 2016 will be 12,707 GWh, corresponding to approximately 71% of the total target. The estimate is that the shortfall in energy savings will be made up primarily through a new extensive energy conservation agreement scheme. Section 4.3 also sets out several actions the savings effects of which will be calculated when the harmonised calculation methods now being prepared by the Commission have been approved by the Regulatory Committee.

Summary of energy conservation effects

Table 1 shows the savings effects by sector achieved by the 14 most significant energy efficiency actions for which it has been possible to make an effectiveness assessment on the basis of the initial data available.

Table 1. Summary of energy savings by sector (GWh)

Sector	2007 GWh	2010 GWh	2013 GWh	2016 GWh
Households				
Buildings	3,960	5,934	7,863	9,573
Public sector/municipal sector	84	69	66	66
Public sector/state administration				
Private services sector	144	90	102	102
Industrial sector	1,286	1,307	743	640
Transportation	869	1,142	1,299	1,387
Agriculture	480	659	809	938
Energy sector				
Horizontal				
Total savings	**6,824**	**9,201**	**10,882**	**12,707**

The new extensive energy conservation agreement scheme is a major new action for the period 2008–2016. Regarding the effects of this scheme, energy savings in the order of the 2,800–4,700 GWh can at this stage be presented on the basis of the coverage intended for those agreements where the principal responsibility lies with the Ministry of Trade and Industry, and the 9% energy conservation targets of individual agreements. These energy savings are additional to the total savings set out in Table 7 which would consequently increase to 15,500–17,400 GWh. No estimate is available yet for the order of magnitude of the effects of the new agreements in the transportation, agricultural and housing sectors.

The need and possibilities to enhance the present actions will be evaluated in conjunction with the preparatory work for the next NEEAP. Planning for the new actions is included in the new energy conservation programme which was drawn up by the end of 2008.

In accordance with Annex II of the directive, the Member States may use a default factor of 2.5 for savings in electricity. In Finland the energy savings of electricity and heat and fuels are, in general, realised in a ratio of 20/80. By using the default factor of 2.5 and including the estimated saving from the new voluntary agreement scheme, the total savings in 2016 would be in range of 19 400–22 200 GWh.

4.2 NEEAP - Denmark

On June 29, 2007 Denmark submitted a comprehensive NEEAP. It has been approved by all major political parties, and is based on earlier established plans of the same kind, which have a long history in Denmark. The current plan sets an annual savings target of 1.15 % of total final energy consumption for the period 2006-2013. From 2010 the target is to be increased to 1.4 % annually. The targets do not include effects of early actions. Almost all the measures in the action plans are already implemented.

Energy Efficiency has for long time had high priority in Denmark, and we have improved energy efficiency in the different sectors and end-uses considerable over the last 25 years. This has – together with a more efficient energy production – made it possible to keep the total primary energy consumption stable over the same period.

In June 2005 the Danish Government and a very broad majority in the Danish parliament made an agreement on future energy-saving initiatives. The agreement sets the framework for energy-saving initiatives as well as the main elements of those initiatives for period form 2006 to 2013. The agreement set an annual saving target at 1.15 pct. of total final energy consumption during the period of 2006-2013. This target, which are higher then the average annual target in directive 2006/32/EC, dos not include any effect of early actions.

Following this agreement was a final *"Action plan for renewed energy-conservation"* published in September 2005. The action plan included the new measures, which were necessary to fulfil the saving target.

The action plan, which includes the political agreement as annex 1, is attached in Danish and in an unofficial English translation. It is our impression that Denmark by this action plan fulfils the requirements in the EU directive.

Almost all the measures in the action plan are implemented and our projections show that they can deliver savings equal to 1.15 pct. per year.

In 2008 a comprehensive evaluation will be made of the initiatives and the results achieved with a view to ensuring that the instruments are sufficient and that the initiatives have been efficiently organised relative to the agreed target.

Intensified Energy Saving Measures, introductory description

The annual energy saving target will be increased to 1.40 % compared to the present target of 1.15 % of final energy consumption annually to 2013. At the same time will transmission and distribution losses be included in the basis for calculation of the annual energy saving target. Taken together, this increases the annual energy saving target from 7.5 PJ to 9.6 PJ, i.e. an average increase of 2.1 PJ over the period 2008-13.

The background for the increased saving target is that there still is a big cost-effective saving potential. There is also a potential for reducing the transmission and distributions losses, especially in the district heating system. It is therefore natural to include these losses in the distributions companies' energy saving obligations. As part of the Political Agreement, the following measures are applied to deliver the increased energy savings:

- In the period 2008-11, an annual DKK 20m will be spent on a new Center for Energy Savings in Buildings including energy saving campaigns, education of construction companies, etc. This will be targeted towards energy savings in existing buildings where a large potential exists.
- From 2010 the energy saving obligations of electricity distribution, gas distribution, district heating and oil supplies is increased from the present 3 PJ/year to 5.4 PJ/year. This increases the total effect to 1.25 % per year. It is expected that this will reduce the effect of some of the other initiatives, cf. table 1.
- From 2010, the energy savings shall be further increased by 1.0 PJ per year, corresponding to the target increase from 1.25 % to 1.40 % annually. The precise implementation of this increase will be decided finally after the agreed 2008 evaluation of the entire energy saving programme.

Table 1: Effects of increased energy savings

	2008	2009	2010	2011	2012	Average 2008-12
Annual savings, PJ						
Included in BAU projection	7.5	7.5	7.5	7.5	7.5	7.5
New measures, PJ						
Campaigns and Center for Energy Savings in Buildings	0.3	0.3	0.3	0.3	0	0.24
Increased obligations on companies	0	0	2.45	2.45	2.45	1.47
To be implemented after the 2008 evaluation	0	0	1,0	1,0	1,0	0,60
Correction for double counting*	0	0	-0.75	-0.75	-0.75	-0.45
Total after Politial Agreement	7,8	7,8	10,5	10,5	10,2	9,36
Increase						
Annual savings, PJ	0,3	0,3	3	3	2,7	1,86
Accumulated savings, PJ	0,3	0,6	3,6	6,6	9,2	4,1
Share outside ETS	50%	50%	50%	50%	50%	50%
CO_2 reduction, 1000 tonnes**	9,75	19,5	117	215	300	132

The increased company obligations will be implemented through orders to the individual companies. The increased effort can take place under existing legislation. After the 2008 evaluation further steps towards higher administrative effectiveness and market orientation will be considered.

Implementation of the extra 1.0 PJ of annual savings will take place following the 2008 evaluation, possibly as a further increase in the company energy saving obligations. The decision to increase the savings by 1.0 PJ annually is part of the Political Agreement. Only the technical implementation remains to be decided in 2008. If not other options are possible will the extra targets be given to the distribution companies.

It is estimated that the increase of the company energy saving obligations will result in extra costs of DKK 400-450m. This includes costs to achieve the extra 0.7 PJ. The costs are paid by the companies. This is expected to lead to increased grid and distribution tariffs to some extent.

4.3 NEEAP - Sweden

A Swedish NEEAP was submitted on January 2008. It concludes that Sweden will reach the 9% target by 2016 with early action results and existing policy measures. But there is still a big potential of further savings, and considering the upcoming 20% target for the year 2020, further strong action is recommended to realise more of the potential. This calls for a new strategy for policy measures. The more detailed design of such measures is presented in a Government Independent Inquiry (SOU), published in October 2008.

Quantification of the indicative target

The national indicative energy savings target means that a reduction in energy end use of at least 9 per cent is to have been achieved by 2016 relative to average energy end use over the period 2001−2005. The energy savings target must be set as an absolute measure expressed in TWh or a corresponding unit. For Sweden, this means, in terms of primary energy use with the application of the weighting factors in Table 1, that a saving through increased energy efficiency of in total 41.1 (32.3) TWh is to be achieved by the year 2016.

Table 2 Quantification of indicative target according to Articles 4(1) and 4(2) of the Directive, TWh

	Primary energy use with weighting factors in accordance with Table 1	Energy end use
Energy use in the base years	456	359
Subgoal 6.5 per cent of energy use in the base years, 2010	30.0	23.3
9 per cent of energy use in the base years, 2016	41.1	32.3

Effects of early actions and policy instruments already decided upon (for the period 1991−2016)

It is clear from Table 3 that the impact of early actions from the period 1991−2005 and the estimated impact for the period 2005−2016 of policy instruments already decided upon are approximately 36 TWh in 2010 and approximately 46 TWh in 2016. This means, still from a primary energy perspective, a total saving of 7.8 per cent in 2010 and 10.1 per cent in 2016.

From an end-user perspective, on the other hand, a savings effect of approx. 21 TWh would be achieved in 2010, with a savings effect of 27 TWh being obtained in 2016. For 2016, this saving equates to approx. 7.5 per cent of energy end use for base years 2001−2005, which on average totaled 359 TWh.

Table 3 Effects of early and existing policy instruments, and policy instruments decided upon, by social sector in 2010 and 2016, TWh

Sector	2010		2016	
	End-use	Primary	End-use	Primary
Early actions 1991/1995–2005				
Housing and services, etc.	11.5	17.9	11.5	17.9
Industrial sector	–	–	–	–
Transport sector	5.0	6.0	5.0	6.0
Existing policy instruments, estimated effects 2005–2016				
Housing and services, etc.	3.6	8.9	8.9	19.4
Industrial sector	0.7	1.8	0.7	1.8
Transport sector	0.7	0.9	0.9	1.1
Summary	21.5	35.5	27.0	46.3
Proportion of average energy use 2001–2005	6.0%	7.8%	7.5%	10.1%

Results and the need for supplementary policy instruments

In 2005, Sweden had, as a result of early actions, achieved a primary energy efficiency improvement equivalent to approx. 24 (16.5) TWh compared with energy use in the base years. If the estimated impact of policy instruments decided upon is also taken into account, approx. 46 (27) TWh primary energy use, i.e. an efficiency improvement of more than 10 per cent, will be achieved in 2016. This should, in the view of the Commission of Inquiry, be regarded as an expression of the calculated actual energy efficiency improvement in the Swedish energy system. The conclusion drawn by the Commission of Inquiry is, in this light, that the energy improvement target is in practice already achieved by the accumulated impact of the early, existing and planned policy instruments.

Great potential for improving efficiency

What has just been stated does not mean that further energy efficiency improvements would be unnecessary or unwarranted. This is due, among other things, to the fact that the Commission of Inquiry has identified significant overall potential for improving energy efficiency in Sweden, which is conservatively put at approx. 65 (40) TWh. A principle adopted in the assessment of the scale of such potential is that only profitable energy efficiency improvements should be carried out.

Generally speaking, the results for the construction sector are considered to be the most reliable, whereas the results for the industrial and transport sectors are subject to greater uncertainty.

Table 4 Estimated economic potential for improving energy efficiency in the respective sectors, TWh

	District heating and fuels [TWh]	Electr [TWh]	Total potential, final [TWh]	Total potential, primary [TWh]
Construction	14	10	25	41
Industrial sector excluding ETS fossil fuels	3	3	6	11
Transport sector	10	-	10	12

5. Calculation of the efficiency potential – final energy pot.

In chapter 3 above we have identified the potential for improved energy efficiency that

- existing policies
- the ESD-directive, and
- other national programmes (e.g. in Norway)

Results in. In the table below a summary of this potential is presented. In the sub sections of this chapter somewhat more detailed tables are shown for each single country.

Table: A summary of the potential for increased energy efficiency in the Nordic countries which has been identified from the NEEAPs and other national plans. The potential aims at reaching 9 % energy efficiency improvements in 2016 in the final user sectors (”final energy”). Industries and other plants that are included in the EU’s emission trading scheme (EU ETS) are not included in the table.

Alla sektorer - Norden	**Norden**		**Sverige**		**Danmark**		**Finland**		**Norge**	
Basår 2003	Läge 2016 Final energy	Läge 2016 Final energy	2016 TWh	2016 %	2016 TWh	2016 %	2016 TWh	2016 %	2016 TWh	2016 %
Energianvändning basår	**965**		**359**		**176**		**208**		**221**	
Tidiga åtgärder & bef styrmedel	52,5	5,4%	25,0	7,0%	10,8	6,1%	10,2	4,9%	6,4	2,9%
Ytterligare potential i NEEAP	**86,0**	**8,9%**	**37,7**	**10,5%**	**23,7**	**13,5%**	**8,3**	**4,0%**	**16,3**	**7,4%**
- utöver 9%-nivån	*51,6*	*5,4%*	*30,4*	*8,5%*	*18,6*	*10,6%*	*-0,2*	*-0,1%*	*2,9*	*1,3%*
Summa	**138,5**	**14,4%**	**62,7**	**17,5%**	**34,5**	**19,6%**	**18,5**	**8,9%**	**22,8**	**10,3%**
Bostäder och servicelokaler										
	Läge 2016 Final energy	Läge 2016 Final energy	2016 TWh	2016 %	2016 TWh	2016 %	2016 TWh	2016 %	2016 TWh	2016 %
Energianvändning basår	**411**		**151**		**85**		**93**		**82**	
Tidiga åtgärder & bef styrmedel	36,0	8,8%	20,4	13,5%	6,0	7,1%	7,7	8,2%	2,0	2,4%
Ytterligare potential i NEEAP	**42,0**	**10,2%**	**20,0**	**13,2%**	**14,7**	**17,4%**	**1,3**	**1,4%**	**6,0**	**7,3%**
- utöver 9%-nivån	*41,1*	*10,0%*	*26,8*	*17,7%*	*13,1*	*15,5%*	*0,6*	*0,6%*	*0,6*	*0,8%*
Summa	**78,0**	**19,0%**	**40,4**	**26,7%**	**20,7**	**24,5%**	**9,0**	**9,6%**	**8,0**	**9,8%**
Industri										
	Läge 2016 Final energy	Läge 2016 Final energy	2016 TWh	2016 %	2016 TWh	2016 %	2016 TWh	2016 %	2016 TWh	2016 %
Energianvändning basår	**285**		**113**		**34**		**58**		**80**	
Tidiga åtgärder & bef styrmedel	6,3	2,2%	0,7	0,6%	2,4	7,1%	1,2	2,0%	2,0	2,5%
Ytterligare potential i NEEAP	**28,9**	**10,1%**	**12,3**	**10,9%**	**5,8**	**17,0%**	**3,8**	**6,5%**	**7,0**	**8,8%**
- utöver 9%-nivån	*9,5*	*3,3%*	*2,9*	*2,5%*	*5,1*	*15,1%*	*-0,3*	*-0,5%*	*1,8*	*2,3%*
Summa	**35,1**	**12,3%**	**13,0**	**11,5%**	**8,2**	**24,1%**	**4,9**	**8,5%**	**9,0**	**11,3%**
Transporter										
	Läge 2016 Final energy	Läge 2016 Final energy	2016 TWh	2016 %	2016 TWh	2016 %	2016 TWh	2016 %	2016 TWh	2016 %
Energianvändning basår	**270**		**95**		**58**		**58**		**59**	
Tidiga åtgärder & bef styrmedel	10,2	3,8%	3,9	4,1%	2,4	4,1%	1,4	2,4%	2,4	4,1%
Ytterligare potential i NEEAP	**15,1**	**5,6%**	**5,3**	**5,6%**	**3,2**	**5,6%**	**3,2**	**5,6%**	**3,3**	**5,6%**
- utöver 9%-nivån	*1,0*	*0,4%*	*0,7*	*0,8%*	*0,4*	*0,8%*	*-0,6*	*-1,0%*	*0,4*	*0,8%*
Summa	**25,3**	**9,4%**	**9,3**	**9,8%**	**5,6**	**9,8%**	**4,6**	**8,0%**	**5,8**	**9,8%**

5.1 Sweden

On the basis of Sweden's NEEAP and additional material from the EnEff investigation, we have in the table below put together an energy efficiency improvement potential for "final energy" in the different sectors. A more exhaustive explanation of the table's numbers and sources can be found in internal reports within the NEP project.

Alla sektorer - Sverige

Basår 2003		Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår			**359,3**
Tidiga åtgärder & bef styrmedel		25,0	7,0%
Ytterligare potential i NEEAP		**37,7**	**10,5%**
- utöver 9%-nivån		*30,4*	*8,5%*
	Summa	**62,7**	**17,5%**

Bostäder och servicelokaler

		Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår			**151,3**
Tidiga åtgärder & bef styrmedel		20,4	13,5%
Ytterligare potential i NEEAP		**20,0**	**13,2%**
- utöver 9%-nivån		*26,8*	*17,7%*
	Summa	**40,4**	**26,7%**

Industri (utanför ETS)

		Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår			**113,0**
Tidiga åtgärder & bef styrmedel		0,7	0,6%
Ytterligare potential i NEEAP		**12,3**	**10,9%**
- utöver 9%-nivån		*2,9*	*2,5%*
	Summa	**13,0**	**11,5%**

Transporter

		Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår			**95,0**
Tidiga åtgärder & bef styrmedel		3,9	4,1%
Ytterligare potential i NEEAP		**5,3**	**5,6%**
- utöver 9%-nivån		*0,7*	*0,8%*
	Summa	**9,3**	**9,8%**

Kort utdrag ur Eneff-utredningen

I tabellen nedan redovisas, baserat på de viktningsfaktorer utredningen använder, den totala, lönsamma energieffektiviseringspotential som utredningen bedömer för närvarande finns inom de tre sektorerna bostäder och service m.m., industri och transporter. Utöver den del av potentialen som kommer att realiseras spontant eller som en följd av tidigare beslutade styrmedel bedömer utredningen att det i dagsläget finns en lönsam potential om minst 56 TWh primärenergi (minst 35 TWh slutlig energi). För att realisera denna potential krävs dock ytterligare styrmedel enligt utredningens bedömning. De förslag som redovisas i slutbetänkandet ska ses i ljuset av detta.

Tabell 3.1 Bedömning av i dagsläget lönsamma energieffektiviseringspotentialer för perioden 2005–2016 (TWh/år)

	Total potential		Potential som kan erfordra ytterligare styrmedel	
	Primär energi [TWh/år]	Slutlig energi [TWh/år]	Primär energi [TWh/år]	Slutlig energi [TWh/år]
Bostäder och service m.m.	41	24	29	16
Industrin	22	13	17–20	11–12
Transporter	16	13	10	8
Total	79	50	56–59	35–36

Om man, med direktivets metodik, lägger samman den potential som framgår av tabellen med effekten av de åtgärder som redan vidtagits under perioden 1995−2005 uppgår Sveriges totala lönsamma energieffektiviseringspotential till cirka 103 TWh primär energi per år, respektive cirka 63 TWh slutlig energi.

I slutbetänkandet föreslås nu, vilket utvecklas nedan, åtgärder som förväntas leda till att en del av denna potential realiseras. Således bedömer utredningen att de föreslagna åtgärderna leder till en energieffektivisering om 17−21 TWh slutlig energi, respektive 30−37 TWh primärenergi. Totalt (inberäknat effekter av tidigare beslutade styrmedel och de åtgärder som nu föreslås) kan Sverige år 2016 därmed uppnå en energieffektivisering på 44−48 TWh slutlig energi respektive 76−83 TWh primär energi. Det motsvarar cirka 12−14 procent slutlig energianvändning eller 17−18 procent primär energianvändning.

5.2 Finland

On the basis of Finland's NEEAP and additional material from VTT we have in the table below put together a potential for improved energy efficiency for "final energy" in the different sectors. A more exhaustive explanation of the table's numbers and sources can be found in internal reports within the NEP project.

Alla sektorer - Finland

Basår 2003	Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår		**208,2**
Tidiga åtgärder & bef styrmedel	10,2	4,9%
Ytterligare potential i NEEAP	**8,3**	**4,0%**
- utöver 9%-nivån	*-0,2*	*-0,1%*
Summa	**18,5**	**8,9%**

Bostäder och servicelokaler

	Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår		**92,8**
Tidiga åtgärder & bef styrmedel	7,7	8,2%
Ytterligare potential i NEEAP	**1,3**	**1,4%**
- utöver 9%-nivån	*0,6*	*0,6%*
Summa	**9,0**	**9,6%**

Industri (non ETS)

	Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår		**57,6**
Tidiga åtgärder & bef styrmedel	1,2	2,0%
Ytterligare potential i NEEAP	**3,8**	**6,5%**
- utöver 9%-nivån	*-0,3*	*-0,5%*
Summa	**4,9**	**8,5%**

Transporter

	Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår		**57,8**
Tidiga åtgärder & bef styrmedel	1,4	2,4%
Ytterligare potential i NEEAP	**3,2**	**5,6%**
- utöver 9%-nivån	*-0,6*	*-1,0%*
Summa	**4,6**	**8,0%**

Latest energy efficiency activities in Finland

In order to replace and update some energy saving agreements that expired in 2007 a third generation of voluntary energy efficiency agreements for the 2008-2016 was prepared.

The energy efficiency agreement of industry and commerce in business and industry was signed by the Confederation of Finnish Industries and its following eight member associations:

- Finnish Food and Drink Industries Federation
- Finnish Energy Industries
- Chemical Industry Federation of Finland
- Finnish Hotel and Restaurant Association FHR
- Finnish Forest Industries Federation
- Finnish Plastics Industries Federation
- Federation of Finnish Commerce
- Technology Industries of Finland

In 2006 the future energy saving potential of industry with energy saving agreement was estimated to be 4.11 TWh/a of heat and fuel and 0.9 TWh/a of electricity energy by the projects that were considered to be implemented. The new energy efficiency targets are depending on the target group (Table 1).

Table 2. Energy saving targets of Finnish industry by 2016.

Target group	Savings
Energy-intensive industry	
All energy-intensive industrial companies in Finland	The target (presented no later than 2010) will reflect the energy efficiency improvement targets set by the companies on the one hand and on the other, the energy efficiency improvement targets of the national Energy and Climate Strategy set at the time
Energy production	
Companies with combined or separate generation of electricity and heat, 80% of energy production	Total saving of 1,000 GWh in the use of primary energy and an improvement of 1,000 GWh in electricity generation calculated in electrical energy by the year 2016 when compared against the situation where these new measures are not taken.
Medium-sized industry and private service sector	
Companies with no sites exceeding a maximum annual energy consumption of 100 GWh. A least 60% of the energy use of the medium-sized industry and private service sector.	The indicative target of energy conservation to be set for each branch will be 9%
Energy services	
Companies delivering district heat and district cooling to end users and those carrying on electricity transmission, distribution and retail sale. The target is to have 80% of the electricity transmitted to end customers (electricity distribution), the electricity sold to end customers (electricity sales) and the district heat sold to end customer.	Saving of 150 GWh of electricity in the transmission and distribution losses of electricity and in the electricity consumption of district heat production and transmission, and a saving of 150 GWh in the distribution losses of district heat and the consumption of fuel energy in separate production by the year 2016 when compared against the situation where no new measures are taken.

By signing the agreement, a company undertakes to analyse its own energy consumption and to draw up an action plan on implementing cost-effective useful efficiency measures. Accordingly, municipalities adhering to the municipal sector agreement scheme are. The new agreements will promote the deployment of new technology and innovation activities more intensively, while including targets and measures for encouraging the use of renewable energy.

With regard to the municipal sector, the Association of Finnish Local and Regional Authorities signed the new framework agreement and added to this, addition at this early stage, a new municipal sector agreements were was concluded by 12 cities and, representing joint municipal authorities, the Hospital District of Helsinki and Uusimaa, Pirkanmaa Hospital District and Lahti Region Educational Consortium. The municipal sector thus achieved coverage of one third on the initial signature date, and more than 30 municipalities and joint municipal authorities are currently preparing their entries into the system.

The voluntary energy saving agreement for residential buildings was signed in November 2002 for the 2002-2012 period. The targets were:

1. 15% decrease in heat and water consumption by 2012
2. Turn electricity consumption to decrease by 2008
3. Get 80% of the communities that have signed the agreement to be analyzed and under consumption follow-up by the end of 2010

Höylä programme is a cooperation programme of the nature of voluntary energy conservation agreements, aimed at improving the energy performance of oil-heated buildings. The programme has the quantitative target of refurbishing 100,000 oil heating systems by 2010. Energy savings of 10–30% can be achieved by reconditioning individual heating systems.

New energy voluntary efficiency agreement of public transport was also started in August 2008. The energy saving target is to decrease energy consumption in transport and the energy efficiency improves 5% by 2010 from the level of 2000. New energy efficiency agreement 2008-2016 for goods transport and logistics was signed in January 2008. The target is set at 9% savings by the year 2016.

5.3 Norway

On the basis of Xrgias presentation of statistics from Enova and comparisons with the other countries' NEEAPs we have in the table below put together a potential for improved energy efficiency for "final energy" in the different sectors. A more exhaustive explanation of the table's numbers and sources can be found in internal reports within the NEP project.

Alla sektorer - Norge			
Basår 2003		Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår			**221,0**
Tidiga åtgärder & bef styrmedel		6,4	2,9%
Ytterligare potential i NEEAP		**16,3**	**7,4%**
- utöver 9%-nivån		*2,9*	*1,3%*
	Summa	**22,8**	**10,3%**

Bostäder och servicelokaler			
		Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår			**82,0**
Tidiga åtgärder & bef styrmedel		2,0	2,4%
Ytterligare potential i NEEAP		**6,0**	**7,3%**
- utöver 9%-nivån		*0,6*	*0,8%*
	Summa	**8,0**	**9,8%**

Industri (alla)			
		Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår			**80,0**
Tidiga åtgärder & bef styrmedel		2,0	2,5%
Ytterligare potential i NEEAP		**7,0**	**8,8%**
- utöver 9%-nivån		*1,8*	*2,3%*
	Summa	**9,0**	**11,3%**

Transporter			
		Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår			**59,0**
Tidiga åtgärder & bef styrmedel		2,4	4,1%
Ytterligare potential i NEEAP		**3,3**	**5,6%**
- utöver 9%-nivån		*0,4*	*0,8%*
	Summa	**5,8**	**9,8%**

Energieffektivisering – erfaringer fra Norge

Det pågår en kontinuerlig diskusjon knyttet til hvorfor ikke det såkalte ”lønnsomme” energieffektiviseringspotensialet i husholdninger, tjenesteytende sektor og industri ikke blir utløst. Mange peker på forhold som manglende informasjon og høye transaksjonskostnader, men det er lite empiriske studier gjort på dette.
Et mulig men på ingen måte perfekt mål på hva forbrukeren oppfatter som kostnader (inkludert transaksjonskostnader) for å gjennomføre tiltak, er den offentlige støtte som må til for at tiltak skal iverksettes. Dette er utgangspunktet for dette notatet.

Datagrunnlag

Det offentlige foretaket Enova SF, som er den norske stats aktør for omlegging til et mer miljøvennlig energisystem, har i 7 år hatt ulike støtteordninger som skal stimulere til energieffektivisering. Hvert år rapporterer Enova hvilke energibesparelser som er oppnådd, og til hvilken kostnad. Det er en forutsetning at Enovas støtte er utløsende for at tiltakene får støtte. Enovas rapportering, inkludert den metodikk som benyttes, revideres regelmessig. VI har derfor tiltro til at dette datamaterialet er av god kvalitet.

Metode

Enovas suksess måles blant annet på antall sparte kWh, og kr/kWh for tiltakene. Det er grunn til å tro at de tiltaktene som har fått støtte først, er de som har trengt minst støtte for å bli utløst. I analysen er det lagt til grunn at tilbudskurven for nye tiltak er stigende, slik at tiltak i fremtiden over tid blir stadig dyrere, og at de blir dyrere enn de tiltakene som allerede er realisert. En rimelig antagelse er at tilbudskurven er loglineær, og at den implisitte priselastisiteten er konstant.
Anslaget på priselastisiteten er til dels empirisk begrunnet. Tallgrunnlaget fra Enova indikerer en priselastisitet for tildelt støtte på fra -1,5 til -2,0. Dette virker noe høyt, og kan være preget av at det er en del ”lavthengende frukter” i utvalget. Vi har derfor på subjektivt grunnlag redusert tallet noe, og benytter -1 i våre beregninger

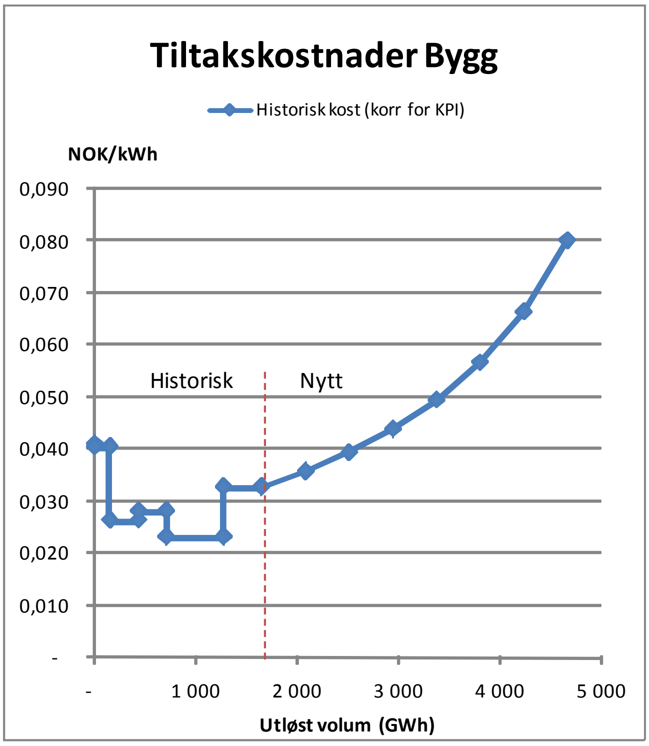
En av de viktigste forutsetningene for å gjennomføre tiltak på forbrukssiden, er forventningen om vedvarende høye, og gjerne stigende, priser på elektrisitet fremover. Dette vil gjøre investeringer i alternativer mer konkurransedyktige, og gi akseptabel tilbakebetalingstid.
I de etterfølgende analysene har vi forutsatt at prisen på elektrisitet har vært konstant i perioden vi ser på historiske data (2001-2006), og at den vil opprettholdes på samme nivå fremover. Dette er selvsagt en betydelig forenkling. Vedvarende høye el-priser stimulerer til omlegging og effektivisering. I og med at prisen har ligget høyt (relativt tidligere år) i den perioden vi har historiske data for, kan det være en viss fare for at vi overvurderer potensialet for energieffektivisering og omlegging. Dersom el-prisene fortsetter å være høye eller stigende, blant annet som følge av effekt av kvotemarkedet, vil potensialet kunne være større.

Bolig

For boliger ble det via det såkalte "strakstiltaket" som Enova gjennomførte i 2003 realisert prosjekter for nesten 130 GWh. I motsetning til for de andre teknologiene, ser vi ikke for oss noen kostnadsøkning her. Dette er hyllevare, der kostnadene heller er redusert enn økt, og det er et meget stort potensial for denne type tiltak.

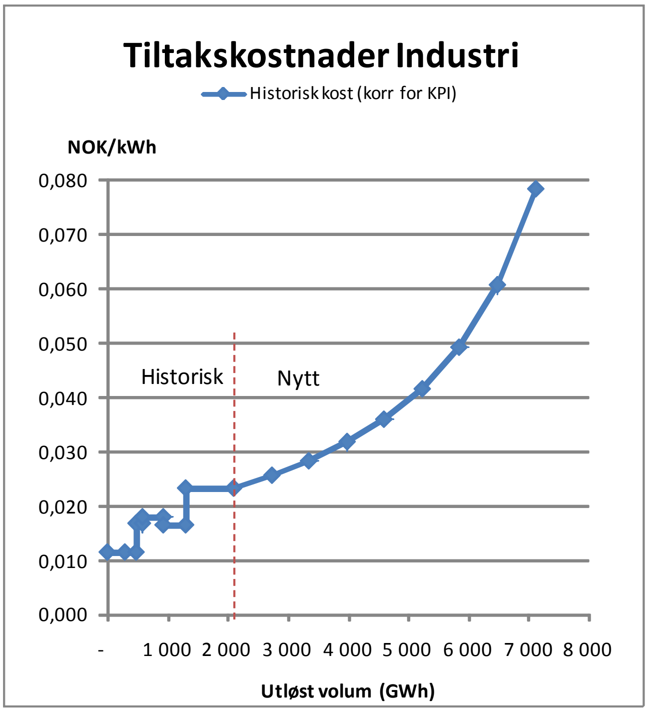
Næringsbygg

For næringsbygg ble det i perioden 2002-2006 realisert tiltak for i alt 1,7 TWh. Kostnaden for tiltakene ligger i området 2,5-4 øre/kWh pr år. Med en priselastisitet på -1 vil tiltakskostnaden fremover stige som vist i figuren til høyre.
Med de gitte forutsetningene finner vi at det bør være mulig å realisere ca 3,5 TWh ytterligere tiltak i bygg innfor en kostnad på 8 øre/kWh. Igjen er det vanskelig å skaffe gode eksterne referanser for å verifisere dette anslaget. I SFTs tiltaksanalyse fra 2005 er det anslått at det er samfunnsøkonomisk lønnsomt å effektivisere 7% av energibruk i næringsbygg. Dette utgjør ca 3,6 TWh. Hvis vi inkluderer realisert potensial fra 2004-2006 i vårt anslag kommer vi til ca 3 TWh. Vårt anslag virker dermed forholdsvis robust.



Industri

For industri ble det i perioden 2002-2006 realisert 1,8 TWh i effektivisering og omlegging. I tillegg kommer ca 300 GWh fra prosjekter igangsatt av NVE i perioden før Enova ble opprettet. Støttekostnaden for tiltakene er lav, i området 1,1-2,5 øre/kWh pr år. Med en forutsetning om en priselastisitet på -0,6, vil tiltakskostnaden fremover stige som vist i figuren til høyre.
Vi har lagt inn et estimat for ytterligere 5 TWh utover det som allerede er realisert i dag. Dette er konsistent med en tiltakskostnad på ca 7,8 øre/kWh. Det er utfordrende å verifisere dette anslaget mot eksterne kilder. En studie fra 2002 gjennomført av PIL/Enova for fire kraftkrevende sektorer[3] konkluderte med et potensial på 5,3 TWh, hvorav ca halvparten den gang ble vurdert som økonomisk gjennomførbart. I Bellona og

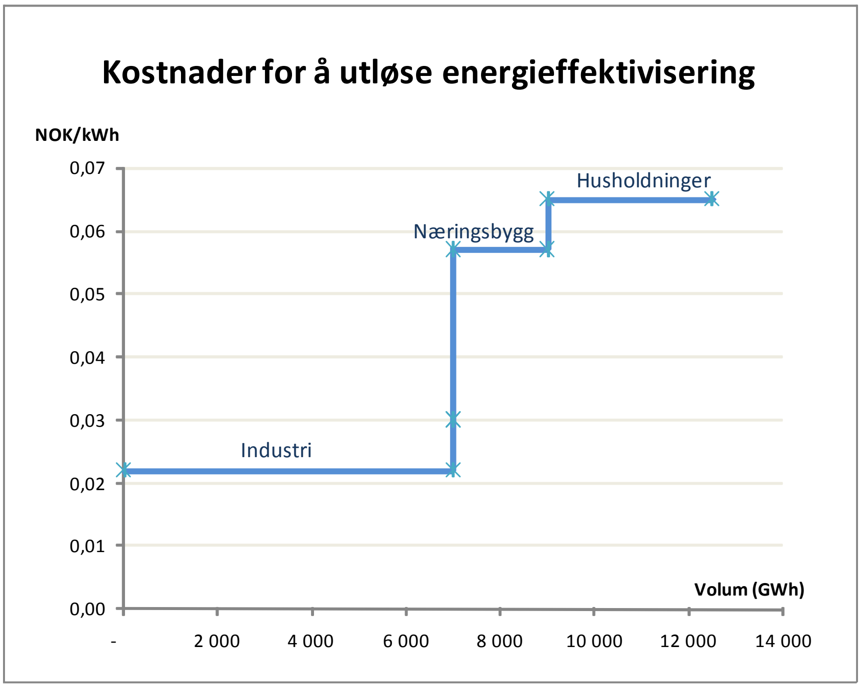


[3] PIL/ENOVA prosjekt 2002: Potensialet for mer miljøvennlig energibruk og produksjon i norsk prosessindustri. Omfatter aluminium, ferro, sement og treforedling.

Siemens rapport om energieffektivisering (september 2007) anslås potensialet for effektivisering i bruk av motorer og økt automatisering til 3,6 TWh. Dette gjelder kun elektrisk kraft.

Samlet effektiviseringspotensial og kostnad

Ser vi på de tre sektorene industri, næringsbygg og husholdninger samlet, er det med de gitte forutsetninger mulig å utløse et relativt betydelig potensial (12-14 TWh)[4] til en kostnad til under 70 NOK/MWh (litt i underkant av 10 €/MWh).



Enovas vurdering av effektiviseringspotensialet

Enovas målsetting er en sum at ulike tiltak knyttet til energieffektiviering, omlegging fra fossile brensler til fornybare, og etablering av ny produksjonskapasitet for elektrisitet og varme. Til sammen har Enova kontraktfestet at de skal nå 18 TWh innen 2016, og 40 TWh innen 2020. Det er opp til Enova selv hvordan dette skal fordeles på ulike tiltak, men minst 3 TWh skal være vindkraft og 4 TWh skal være fornybar varme.

Når det gjelder Enovas egne vurderinger av effektiviseringpotensialet, er det tro på at om lag 15 TWh kan spares uten vesentlige investeringer. Figure 0 3 er hentet fra et foredrag adm. Dir. Nils Kristian Nakstad holdt på Enovas varmekonferanse i januar 2009.

Figure: Enovas evaluation of the potential

[4] Det har i materialet som er studert ikke vært mulig å skille ut enkelttiltak og enkeltteknologier, slik at noe av potensialet utgjøres av en omlegging fossile brensler til fornybar energi.

5.4 Danmark

On the basis of Denmark's NEEAP, additional material and comparisons with the other countries' NEEAPs we have in the table below put together a potential for improved energy efficiency for "final energy" in the different sectors. A more exhaustive explanation of the table's numbers and sources can be found in internal reports within the NEP project.

Alla sektorer - Danmark		
Basår 2003	Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår		**176,4**
Tidiga åtgärder & bef styrmedel	10,8	6,1%
Ytterligare potential i NEEAP	**23,7**	**13,5%**
- utöver 9%-nivån	*18,6*	*10,6%*
Summa	**34,5**	**19,6%**

Bostäder och servicelokaler		
	Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår		**84,6**
Tidiga åtgärder & bef styrmedel	6,0	7,1%
Ytterligare potential i NEEAP	**14,7**	**17,4%**
- utöver 9%-nivån	*13,1*	*15,5%*
Summa	**20,7**	**24,5%**

Industri (alla)		
	Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår		**34,0**
Tidiga åtgärder & bef styrmedel	2,4	7,1%
Ytterligare potential i NEEAP	**5,8**	**17,0%**
- utöver 9%-nivån	*5,1*	*15,1%*
Summa	**8,2**	**24,1%**

Transporter		
	Läge 2016 Final energy	Läge 2016 Final energy
Energianvändning basår		**57,8**
Tidiga åtgärder & bef styrmedel	2,4	4,1%
Ytterligare potential i NEEAP	**3,2**	**5,6%**
- utöver 9%-nivån	*0,4*	*0,8%*
Summa	**5,6**	**9,8%**

Savings potentials in Denmark

Although significant energy savings have been achieved for several years, there are still major, profitable potential savings. New savings potentials are constantly being made possible as a result of technological development, and although savings are being made, there is, therefore, no substantial reduction in the potential.

Using low-cost measures, the profitable, cost-effective savings potential with today's technology is estimated at the present time to be at least 10% of the energy consumption. If savings are realised when equipment, processes and buildings are being improved, maintained or replaced, it will be possible to realise attractive cost-effective savings amounting to nearly 25% over the next 10 years, assuming technological development due to i.a. increased research and development.

<u>Assumptions for potential calculations:</u>
The socio-economic potential consists of the economically-profitable savings possibilities. Calculations show that the following private-economy payback times result in socio-economic balance:

- Households, etc.
  - Electricity: 5-3 years
  - Heat: 4-8 years
- Business/Industry
  - Electricity: 4-8 years
  - Process energy: 8-15 years

When calculating private economy savings potentials in the short term, payback times of 0-2 years have been used for business/industry and 0-4 years for other sectors. For space-heating savings, a payback time of 8-10 years is calculated as a result of the long lifetime of the savings. If the savings are financed by mortgage credit loans, they will provide a profit for consumers from day one.

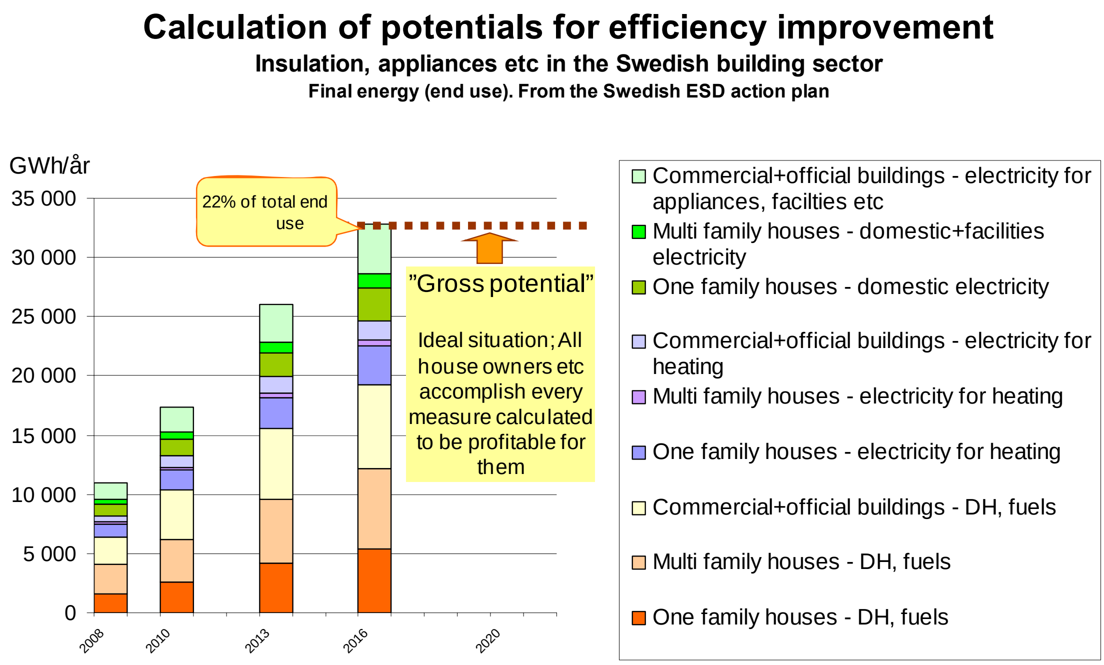
Table 1: Potential for energy savings in various areas.

End use	Final energy consumption 2003 (PJ)	Socio-economic potential up to 2015		Private-economy potential (%)	
		%	PJ	Currently	Up to 2015
Space heating	217.6	24%	51.3	18%	47%
Industrial processes	66.5	25%	16.5	13%	27%
Lighting	24.0	24%	5.7	19%	60%
Cooling/freezing	15.1	28%	4.3	10%	35%
Electric motors	12.4	15%	1.9	10%	30%
Ventilation	11.9	40%	4.8	13%	38%
Pumping	8.4	35%	2.9	14%	42%
Other	71.3	24%	17.2	11%	33%
Total	**427.2**	**24%**	**104.5**	**16%**	**42%**

Note The savings potentials show how much can be saved in relation to today's energy consumption, that is, without growth in the energy-service level. Some of the potential will be realised as part the current efficiency improvement and is therefore included in the energy-

6. Calculation of size of the efficiency potential – residential and commercial buildings in Sweden as an example

The figure below, from the Swedish EnEff inquiry, shows the private economic (or the "decision maker economic") *"gross potential"* in buildings. In this case, the gross potential for the year 2016 is about 22% of the total final energy use. The concept "gross potential" refers to what is private-economically (or "decision-maker economically") profitable in a present-value calculation, with 6% calculation interest rate and 2% real energy price increase. The potential includes all types of measures (supplementary insulation, ventilation, change of electrical equipment, etc.), both as separate measures and ongoing in connection with replacements and repairs that must be done anyway. Changes of heating technology (conversions) are not included. The implementation is distributed over time according to usual lifetimes for apparatuses, building parts etc.



Är procentberäkningarna realistiska?

Hur väl stämmer beräkningarna i Eneff-utredningen med det som i verkligheten tas fram åt husägare i dagens bebyggelse? Vi har genom det svenska Boverkets tillmötesgående kunnat få tillgång till avidentifierade data från de ca 13.000 energideklarationer som i juli fanns registrerade. I detta material finns bland annat nuvarande energianvändning (energiprestanda) och föreslagna lönsamma sparåtgärder. "Lönsamma" är då definierade på samma sätt som de "beslutfattarekonomiskt lönsamma" i figuren ovan. Energideklarationernas åtgärder är angivna och registrerade med en klassning av åtgärdstyp, en fritext (ofta mycket utförlig) om vad åtgärden avser, samt hur mycket energi den sparar.

Materialet har bearbetats av Profu. Vissa objekt togs bort eftersom de saknade siffror på energieffektivisering, och i några fall var siffrorna uppenbart orimliga. Genom att filformat var svårbearbetat (svårt att koppla energiprestanda till en översikt över husets alla åtgärder) gjordes bearbetningen enbart för några stora län, däribland storstadslänen.

De framtagna åtgärdsförslagen ger en bra bild av vad som idag av energiexperter verkande i dagens bebyggelse bedöms som lönsamma åtgärder för en husägare i en kalkyl som motsvarar vårt ”lönsamhetsbegrepp” ovan. Resultatet uttryckt i minskningsprocent blev enligt nedan.

Resultat från bearbetning av energideklarationer inkomna till Boverket juli 2008

Typkod Hustyp	Föreslagna åtgärders minskade energianvändning, vägt genomsnitt
220 Småhus 1-2 familjer	21 %
320 Flerbostadshus, bostäder	13 %
321a Flerbostadshus, med lokaler under 50%	14 %
321b Flerbostadshus, med lokaler över 50%	15 %
Skattepliktiga lokaler	
325 ”Hyreshus” med övervägande lokaler	14 %
322 Hotell och restaurang	17 %
326 Kontor på industrimark	21 %
Icke skattepliktiga (specialenheter)	
823 Vårdbyggnader	24 %
824 Bad, sport, idrott	28 %
825 Skolbyggnader	17 %
826 Kulturbyggnader	21 %
828 Allmänna byggnader (förvaltning etc)	17 %
829 Kommunikationsbygg ander	17 %

Dessa siffror skall jämföras med de 22% som Eneff-utredningen beräknat i beslutsfattarkalkylens ingenjörsposter. Tabellen ovan tyder på att Profus beräkning ligger på en realistisk nivå.

6.1 The “gross potential” shows an ideal situation

The “gross potential” shows an ideal situation where all house owners make a correct calculation and then implement everything, and it becomes the starting point for calculation of a realistic level of implementation (see below).

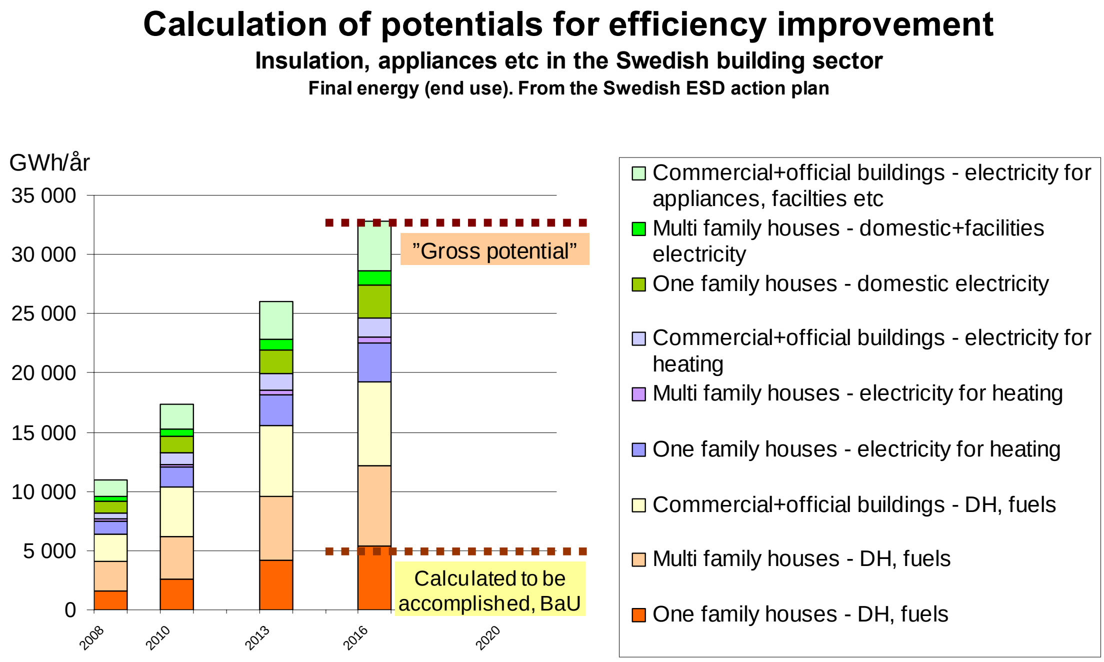
This type of calculation often gives rise to objections and skepticism. It may be questioned whether the basis is correct in purely technical terms (are there really so many possibilities for energy efficiency?). In particular, discussion arises over whether this can be called “profitable”. Since it is an ideal cases where everyone has complete knowledge, has time to carry out measures, etc., in reality only a portion of them will be implemented; only what is really done reflects what the actors find “profitable”, according to the objection.

Regardless of this conceptual discussion, we think that the charting of the ideal gross potential is valuable. It provides a point of departure for continued analysis, and a quantification of the “possibilities” to start with. But it is important that one gives this calculation a correct presentation. One must also be careful with concepts such as “technically feasible” potential, or “technical-economic” potential, and then explain clearly what they mean.

Another comment: We are speaking above of how the end users/actors calculate and act. A *socio-economic analysis* needs to be done in a different way. There, for example, the real variable costs for energy may be different from what tariffs and price lists say.

6.2 How much of the "gross potential" is spontaneously implemented

Only a part of the gross potential will be spontaneously implemented in reality. This has been established and described in a large number of contexts and inquiries. The Swedish EnEff inquiry judges that *only about 15%* of the house measures (excluding conversions) will be implemented[5] in a business-as-usual case (level ca. 5 TWh in year 2016; see figure below).



In the figure, the concept "acceptance" is used for the part that is implemented. The fact that only a part is implemented has sometimes been described as "the energy efficiency gap/paradox", or as the result of "transaction costs" or "barrier effects" for energy efficiency.

Obstacles to implementation

There are many reasons why not everything is implemented. One may have deficient knowledge that improved efficiency possibilities exist, one may doubt the suitability of certain measures, one may have stricter profitability requirements or problems with financing, one perhaps calculates profitability too narrowly or short-sightedly, one may doubt whether the

[5] This judgement builds on a Chalmers report from 2005 which analyzed the real trend of energy use during 1993 – 2003. The conclusion was that the real implementation of efficiency measures had been much less than the most cautious assessment of realistic implementation which the 1995 energy commission made for this period, even though the economic preconditions had been more advantageous. The Chalmers report judged that the "acceptance" in the future may lie in the interval 10 to 30% depending on how policy instruments etc. are designed, where the higher level would require strongly sharpened instruments compared with today.

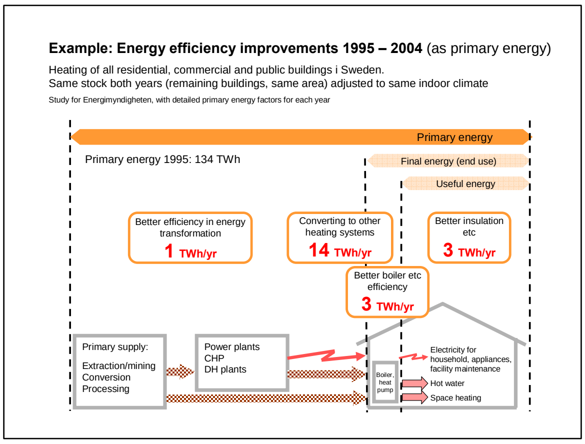
business will last in its present form, one lacks time to handle this type of issue or produces an inadequate basis, the organization does not have sufficient competence or is focused on other issues, etc.

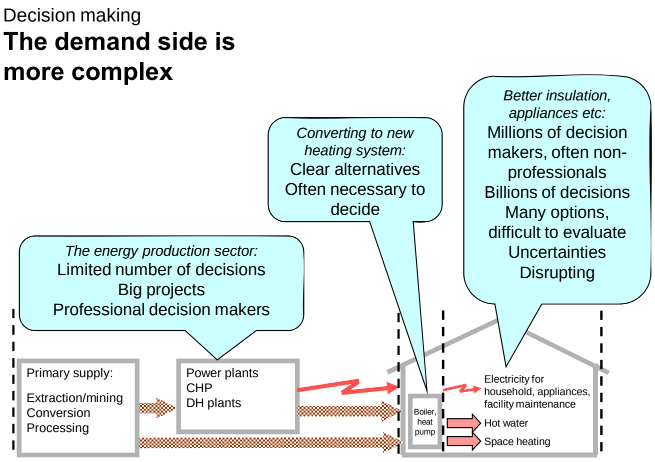
The description of these implementation problems may need to be deepened. Here we emphasize two rather troublesome obstacles:

- *Organization and "split incentives"* for premises and multi-residential buildings. For most public and commercial premises, the distribution of roles between owner and users often leads to an unfavourable structure of incentives. The owner must pay for most of the energy measures but the tenant reaps the profit, at least in the case of basic rent. Even with total rent (including heating) there are problems – the tenant has no incentive to behave energy-efficiently. Moreover, the trend that whoever runs a business sells the building where the business is run, and perhaps also outsources the building's administration, leads to a more complex structure which can make measures harder to implement. In multi-residential buildings, the owner normally pays for the investment in e.g. white goods, while the tenant pays the electricity bill. An ECEEE study has analyzed the residential sector in several countries and shows that ca. 25% of all energy there has what are called "principal agent problems", i.e. that those who cause the use of energy are not those who have access to the efficiency measures, or do not get any price signal about their energy behaviour.

- *"The investor market"*. This concept is sometimes used of large owners where the ownership is governed to a high degree by financial motives. About 1/3 of the area of Swedish buildings with premises is owned by such owners who, crudely expressed, focus on refining the use (to extract higher rent) or buy and sell buildings rather than lowering their operating costs.

Different "decision power" in different parts of the energy system
Generally it is easier to get measures and decisions implemented on the side of energy supply, distribution, and large-scale conversion, than on the user side in houses. Construction of power plants, heating plants or power grids is handled by professional organizations in a limited number of (rational) decisions. To realize the efficiency improvement potential on the user side requires often millions of decisions by millions of small-house owners, tenants, and people in owner and administrator organizations, for whom energy is often only a fraction of all the issues they must deal with.



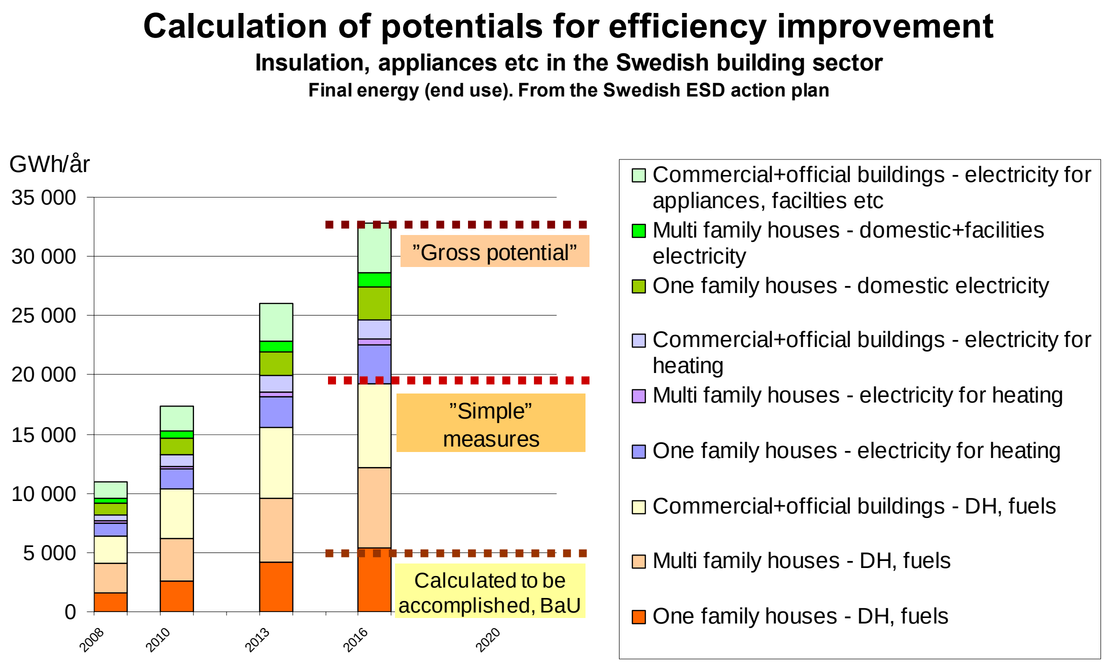


6.3 How much of the "gross potential" should be easy to realize?

All of the measures in the "gross potential" are profitable in calculation terms, but naturally their profitability differs. A very large part of the measures are actually quite simple to implement, and many of them cost nothing in investment. We have separated out such "simple measures", such as:

- Adapting air flows, and operation times for ventilation and illumination, to the times when premises are used. This often requires only the right adjustments of existing clocks or the like.
- Electricity efficiency in households, buildings and businesses, in the form of change to the best on the market when changes are to be made anyway. Change to low-energy lamps.
- Insulation of attics.

These simple and cheap measures constitute more than half of the entire gross potential; see the figure below! The "easily accessible potential" is thus much greater than what is implemented in reality. (And what is implemented may not be the most profitable – experience from elsewhere indicates that real implementation is widely spread between the more and the less profitable).



Our conclusion is that there are certainly obstacles (e.g. transaction costs) which lead to a great deal not being done, but that the house owner has many very profitable possibilities within reach when the obstacles have been passed. Policy instruments that help the decision-maker over the obstacles seem to be well justified!

6.4 The efficiency gap

EnEff-utredningen har djupgående diskuterat ”energieffektivseringsgapet”, alltså att till synes lönsamma åtgärder inte blir genomförda, och hur orsakerna till detta kan systematiseras. Det finns också noggranna diskussioner om vad som skall definieras som ”marknadsmisslyckanden” respektive ”marknadsbarriärer” allmänt.

Eneff-utredningen har också, genom arbeten som Profu genomfört, så långt det är möjligt försökt hitta specifika och konkreta orsaker till gapet, och att uttrycka dem i siffror där detta är möjligt. Så långt möjligt ville vi alltså införa dessa faktorer i kalkylerna, och se hur de påverkade resultatet i form av effektivisering. Det gap vi talar om i detta fall, är hela skillnaden mellan resultatet av ingenjörskalkylen respektive det som förväntas genomföras spontant, med nuvarande styrmedel. Tabellen nedan visar vilka faktorer vi kunnat kvantifiera:

Summering

Faktorer vi kvantifierat:	Faktorer som inte kunnat kvantifieras:
Externa effekter	Begränsad kunskap och information
Transaktionskostnader	Institutionella hinder (delar)
Split incentives	Finansieringssvårigheter
Osäkerhet, riskvärdering	Tidsbrist, ointresse
Investerarmarknaden	

Som exempel ger vi nedan en kortfattad genomgång av hur vi hanterat transaktionskostnader:

Definition av transaktionskostnader

Generellt brukar man med transaktionskostnader avse sådana kostnader som uppkommer, och måste uppkomma, för att få till stånd ett köp. Den som söker en viss tjänst eller produkt måste lägga ner en viss tid och ett visst arbete samt eventuella andra kostnader för att köpet skall kunna bli genomfört. Denna ganska breda definition medför att man träffar på olika omfattning av begreppet ”transaktionskostnad” i litteraturen och i samspråk med ekonomer. Ibland tenderar det att syfta på alla eller en stor del av de faktorer eller ”hinder” som medvetet eller omedvetet måste ingå för att man skall få hela bilden av att ex.vis en energiåtgärd blir genomförd eller ej.

I vårt arbete har vi använt ”transaktionskostnad” i en mer avgränsad betydelse: Den insats som åtgår för köparen av en energiåtgärd, från det att idén om åtgärd uppstår, inklusive att skaffa information, undersöka möjliga alternativa utföranden, leta upp utförare eller leverantörer, förhandla med dem, beställa, hålla kontakter under utförandet, följa upp samt utvärdera genomförandet.

Den insats som säljaren behöver lägga ned för att få till stånd åtgärden antas vara inkluderad i det pris som köparen betalar. Den är alltså redan inkluderad i ingenjörsposten.

Definitionen betyder att vi främst värderar transaktionskostnad som en tidsåtgång, som vi sedan kan sätta ett timpris på. Ibland kan tillkomma utlägg för att åka och titta, eller köpa in något informationsmaterial.

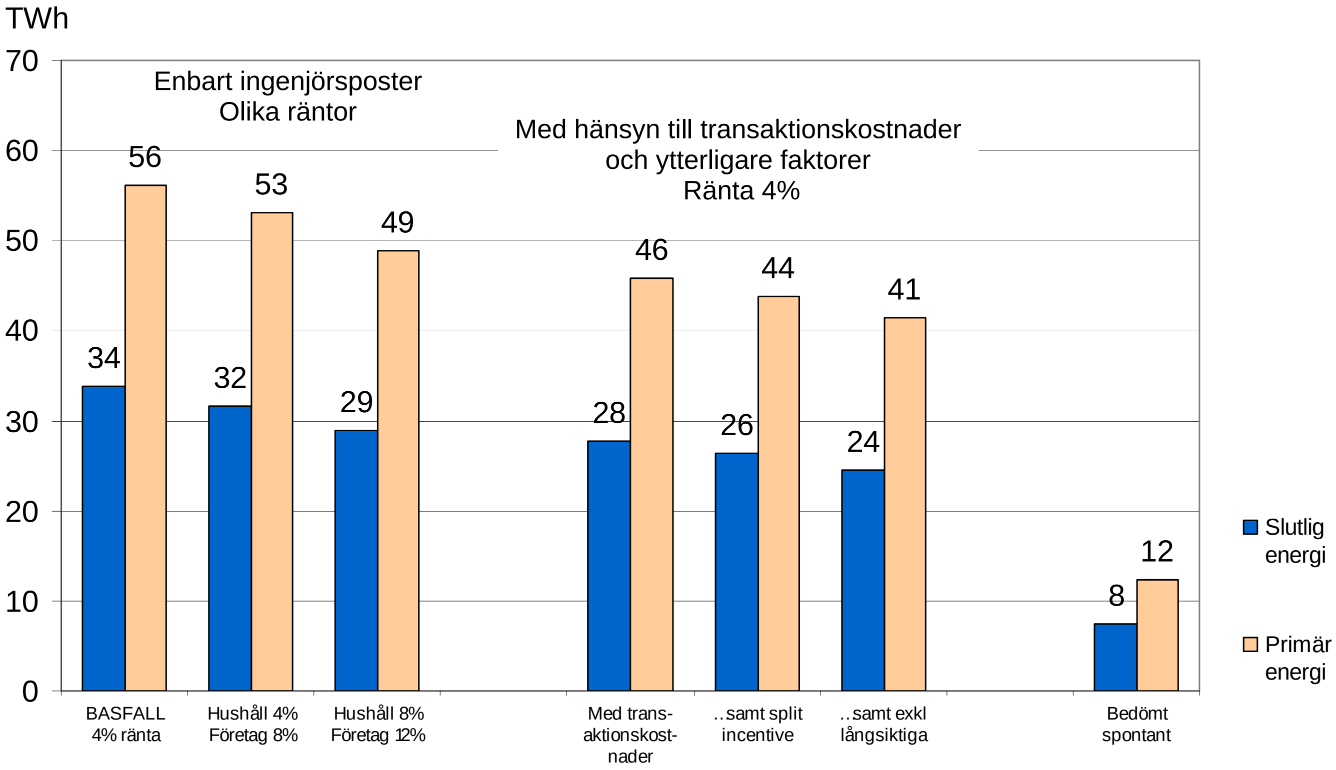
Litteratursökning

Vi vill kunna basera våra beräkningar på empiriskt material om hur stora transaktionskostnaderna är för energiåtgärder. Begreppet är ju ofta behandlat i litteraturen, och vi har genomfört en ordentlig litteratursökning. Den övergripande slutsatsen är, att det finns en stor mängd artiklar som behandlar transaktionskostnader principiellt eller i fallstudier, men att endast ett litet fåtal ger faktauppgifter som kan användas för den beräkning vi vill göra. Vi behöver veta hur många timmar som lagts ned eller hur stor tidsåtgången eller kostnaden är i relation till exempelvis investeringen. Detta är mycket sällan undersökt och rapporterat. Denna slutsats bekräftas av samtal med några av de ekonomer och andra forskare vi haft kontakt med under utredningsarbetet.

Vår metod för att beräkna transaktionskostnaden har därför istället varit, att vi för varje åtgärd gjort en egen bedömning av antal timmar – och kostnaderna för dessa - som åtgår för husägaren och hans anställda (respektive familjemedlemmar) att skaffa fram information, handla upp, följa upp etc. Denna bedömning har dock ibland kunnat hämtas från eller få stöd från några referenser vi funnit:

Beräkningar

Figuren nedan visar längst till vänster basfallets utfall (”gross potential”) med enbart ingenjörsposterna medtagna (34 TWh slutlig energi), och längst till höger den bedömda spontana effektivseringen (8 TWh). Vad beror skillnaden på? Staplarna däremellan försöker ge en del av svaret.

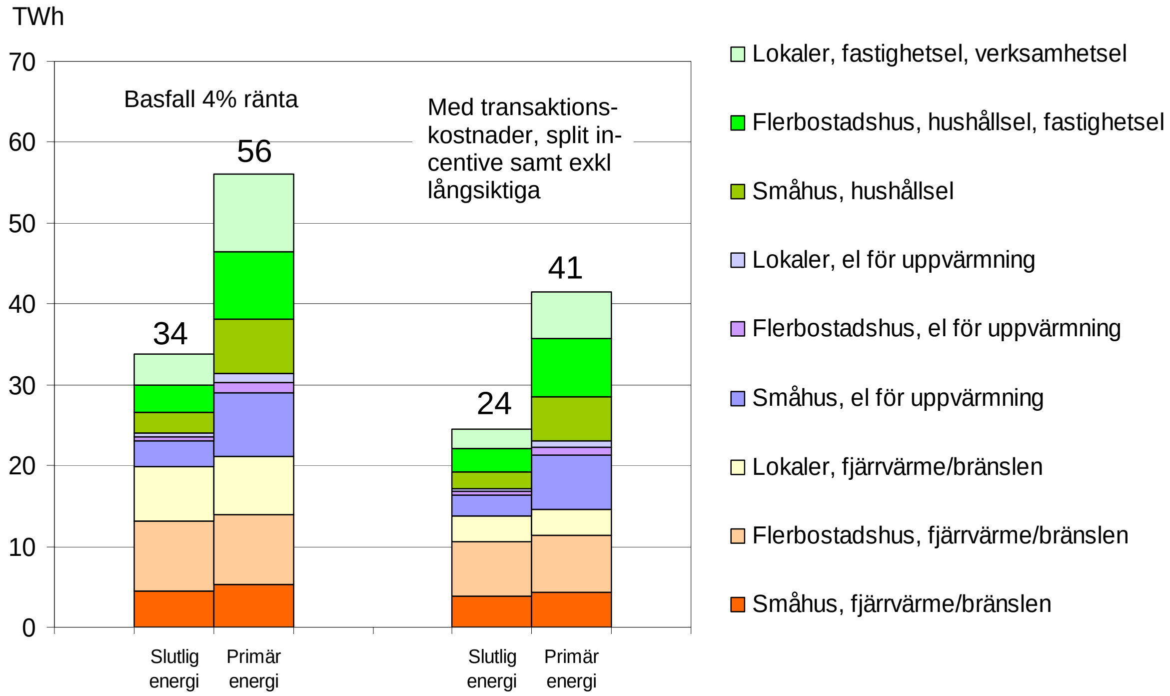


Effektiviseringspotential läge 2016. Beslutsfattarkalkyler. Enbart ingenjörsposter med olika diskonteringsränta. Reduktion av potential med hänsyn till transaktionskostnader, och split incentives, och att vissa långsiktiga åtgärder kanske inte görs.

Längst till vänster i figuren visas utfall vid *olika ränta*. Basfallet med 4% real diskonteringsränta för både hushåll och företag har potentialen 34 TWh (slutlig energi). Ökar man till 8% för företag så minskar potentialen till 32 TWh, och om man skärper till 8% för hushåll och 12% för företag blir det 29 TWh, alltså ca 85% av 4%-fallet. Skärpta räntekrav påverkar inte potentialen mer än så, eftersom en ganska stor del av åtgärderna är tämligen enkla åtgärder med liten investering eller arbetsinsats. Exempel: Anpassa driftstider på ventilation, inreglering, bättre styrning av värme, ersätta glödlampor med lågenergilampor.

Staplarna i mitten av figuren visar vad som händer när vi också söker inkludera andra typer av kostnader än de som passerar plånboken:

För varje åtgärd har vi gjort en överslagsberäkning av den tid det tar för husägaren och hans anställda (respektive familjemedlemmar) att skaffa fram information, handla upp, följa upp etc. Underlag och definitioner beskrivs utförligt i Eneff-utredningen. Tidsåtgången har omvandlats till pengar med den tidsvärdering som diskuteras ovan. Beloppet har lagts till investeringskostnaden, och därmed minskar lönsamheten jämfört med kalkylen med enbart ingenjörsposter. Pålägget i förhållande till investeringskostnaden kan vara ganska litet för större åtgärder (i klassen 5 à 20%). För vissa billiga åtgärder såsom anpassning av ventilationens tider och flöden kan husägarens kostnad bli lika stor som, eller större än, kostnaden för det inköpta arbetet.



Denna figur visar en uppdelning på hustyper och energislag för några fall av de beslutsfattarkalkyler som finns i figuren ovan. Enbart ingenjörsposter

Med transaktionskostnader inkluderade på detta sätt och ränta 4% minskar potentialen från 34 TWh slutlig energi till 28 TWh (82% av basfallet). Denna beräkning är gjord med väl tilltagna tidsåtgångar, och en tidsvärdering i kr/tim som kan bedömas som hög: 115 kr/tim för privatpersoners egen fritid. Adderar vi därutöver också inverkan av split incentives (se avsnitt ovan) och ”investerarmarknaden” (se avsnitt ovan) innebär det att potentialen (vid 4% ränta) minskar till 24 TWh slutlig energi, vilket är 72% av basfallet.

Vi kan också konstatera, parentetiskt, att denna potential på 24 TWh är av samma storleksordning som den bedömning av ”potentialen för enkla åtgärder” (cirka 20 TWh) som gjordes i avsnitt 6.3 ovan.

How energy efficiency progress is modeled in the Primes model?

The European Commission frequently uses the Primes model in their energy policy analysis. Below it is described how energy efficiency progress is modeled in the Primes model.

"Engineering-oriented analysis points to the existence of energy saving potentials that may be achieved without extra cost to the energy system, or even at negative costs. However, there is evidence from statistics that consumers do not act as expected by engineering-oriented analysis.

The PRIMES model takes the view that in reality "hidden" costs explain why consumers do not exploit this so-called no-cost energy saving potential. They have to be motivated by some price signal or by command-and-control policies. Factors such as lack of information, risk associated with the adoption of new technologies (such as possible lack of maintenance or lower technical reliability), market barriers (associated with the effort of equipment sellers to keep selling the old inefficient equipment), disutility (less comfort) and lack of appropriate standards bring about true costs for the consumer and explain the observed behaviour.

Any energy efficiency investment involves higher expenditure for investment cost (purchase of more efficient equipments and appliances or works for insulating buildings and houses) and lower expenditure for operation because of fuel savings. The pay-back period depends on the discount rate. Engineering-oriented analyses adopt rather low discount rates. However, statistical studies have shown that the discount rates used by consumers are much higher, reflecting lack of sufficient wealth (or cash) or high preference for holding savings in cash form. These high rates are often called subjective discount rates as opposed to business discount rates.

The PRIMES model represents the hidden costs associated with the choice of new equipments as perceived costs that differ from engineering costs. In addition, the model uses subjective discount rates, which vary between 12 and 20% depending on the size of the consumer, contrasting for example 8 – 9% rates that are used for utilities.

The model takes the view that energy efficiency investments which are included in the Baseline scenario are driven by market forces. Consequently, for scenarios that include emission or similar constraints which drive energy efficiency investments further, the model evaluates positive (and not zero or negative) additional costs.

Another explanation of positive costs of energy efficiency is the so-called rebound effect. A rebound effect, i.e. more consumption of energy than expected by engineering analysis of energy savings, occurs when energy efficiency improves. If energy efficiency improvement saves money for the consumer, he or she may increase consumption, including energy. The net effect cancels part of the energy savings."

6.5. Policy instruments for more effective use of energy

The above reasoning shows that there seem to be large possibilities for improved energy efficiency, and that this would justify the introduction of policy instruments. First we give a more general reasoning about policy instruments for effective energy use. The commonest arguments for this are:

1) The price of energy is too low
Costs in the form of emissions of polluting substances or risks of serious accidents are not sufficiently included in the energy price. In economic language one usually says that negative external effects are not internalized in the price. If this is the case, the natural measure is to adjust the energy taxes, or to introduce new justified fees. Another advantage of internalizing external effects through taxation is that it creates leeway for lowering socio-economically "bad taxes".

There may, however, be reason not to internalize all negative external effects through taxes and fees. Such an example is taxation of competition-exposed energy-demanding industry. In the interest of companies' international competitiveness, one does not want to introduce higher taxation of one's own country's companies than what the competitors pay. This is a clear example of when special efforts to promote energy efficiency can be justified.

2) The costs of energy are not paid (directly) by those who can influence the use of energy.
This "principal agent" problem has been described above. An example is the landlord who makes decisions as to which refrigerators will be purchased, but who then does not stand for the running operation costs. If, on the other hand, the landlord pays electricity for an apartment, the tenant has no incentive to keep down the electricity bill in other respects. A way to circumvent this concrete problem is to introduce a minimum standard on white goods' energy efficiency in rental buildings.

3) In order for us as consumers to be able to make rational decisions, knowledge is needed, but it is sometimes effective instead to limit the choices by having the state place requirements on the products that are sold.
In certain cases, there are technical solutions which lead to such superior energy performance that we as consumers would very probably choose these, provided that we are sufficiently well informed. This may apply, for example, to the energy consumption in new residences, or so-called "stand-by" consumption in electrical equipment. The problem may be that we as consumers are unable to absorb this knowledge since there are so many other aspects that we must attend to as consumers. This is a motive for introducing different types of technical standards or functional requirements.

4) A certain type of activity yields positive diffusion effects (positive external effects).
Research is often cited as an example of activity where private actors cannot get paid for the entire value of their activity. There are, of course, opportunities for obtaining patents, but this protection is far from comprehensive. By supporting research, the state can also guarantee that many people learn about the results of research. The same argument is given for the state's contributing to information and knowledge diffusion in general. Support for municipal energy advisers, state-financed information campaigns, and publicly financed education has been in all cases an important component in the state policy for promoting effective use of energy.

A concept common to these four motives for state policy is “market failures”. This means that a free and unregulated market cannot be expected to lead to socio-economically effective solutions. However, it should be noted that it is not enough to identify market failures in order to justify political measures; another requirement is that the profit of introducing new policy instruments is higher than the costs. Examples of costs that must be taken into account are administrative costs for carrying out the policies, and extra costs that arise when state expenditures must be financed, so-called tax wedges. It may also be that the policies themselves entail other negative effects; for instance, grants for energy-efficiency measures may mean that the “normal” market is affected negatively. Everyone has to invest simultaneously in what receives support, and other measures are delayed for the future, while we as consumers become passive and expect continued support in order to take steps.

Proposals for policy instruments

Exempel på möjliga policyåtgärder från samhällets sida för att undanröja eller mildra effekterna av de hinder som identifierats ovan är:

1. Olika typer av skatter, prisreglering eller konkurrenslagstiftning som syftar till att säkerställa att de priser som aktörerna möter verkligen speglar den samhällsekonomiska resursuppoffringen
2. Frivilliga avtal med energianvändare om att minska energiförbrukningen
3. Strengthened status and prominence for energy declarations. Support for implementation of proposed measures
4. Regleringar kan också vara en effektiv metod att sänka aktörernas kostnader för informationsinhämtning eller som alternativ till beskattning
5. Building codes with energy-conservation requirements for rebuilding
6. Better rental agreements with incentives for improved energy efficiency
7. Investeringsbidrag för att påskynda introduktionen av ny teknik
8. Stöd till forskning
9. Stöd till utbildning och information
10. Regleringar i syfte att skydda konsumenterna mot farliga produkter
11. Continued promotion of Energy Performance Contracting

Bedömd inverkan av ett antal styrmedel

Följande fyra styrmedel och dess inverkan på energianvändningen analyserades i Eneff-utredningen:

- "Förbud mot glödlampor" (jämför punkt 4 ovan)
- Individuell varmvattenmätning (jämför punkt 6 ovan, men också resonemanget om split incentives i avsnitt 6.2)
- Ombyggnads-BBR (jämför punkt 5 ovan)
- Fondsystem för energideklarationers åtgärder (jämför punkt 2 om frivilliga avtal och punkt 3 om energideklarationer)

Utredningen motiverade valet av dessa styrmedel med att de skulle kunna ”överbrygga” flera av de hinder som man identifierade som viktigast att överbrygga för att kunna få en stor energieffektiviseringspotential genomförd.

Mer om förutsättningarna beskrivs efter tabellen på nästa sida.

Bedömd inverkan av föreslagna styrmedel

Förslag till nytt styrmedel	Slutlig energi, GWh/år	Primär energi, GWh/år
"Förbud mot glödlampor"	1 700	5 700
Individuell varmvattenmätning	2 000	2 200
Ombyggnads-BBR	3 700	5 500
Fondsystem för energideklarationers åtgärder (jämför frivilliga avtal)	5 200	7 500
Summa (ej dubbelräkning)	**12 600**	**20 900**

Alla beräkningar av styrmedels möjliga inverkan avser vad som kan uppnås utöver den spontana utvecklingen. De är i detta fall också gjorda så, att inverkan mellan olika styrmedel inte dubbelräknas (inverkan har antagits med tabellens ordning).

"Förbud mot glödlampor" skulle snarare vara ett krav på viss eleffektivitet på ljuskällor. I praktiken torde ett krav inte kunna omfatta samtliga glödlampor, och vi har antagit att ca 1/3 av hemmens glödlampor ändå finns kvar.

Individuell varmvattenmätning antas också i praktiken kräva undantag för t.ex. de minsta flerbostadshusen, och 10% av lägenheterna är bortträknade.

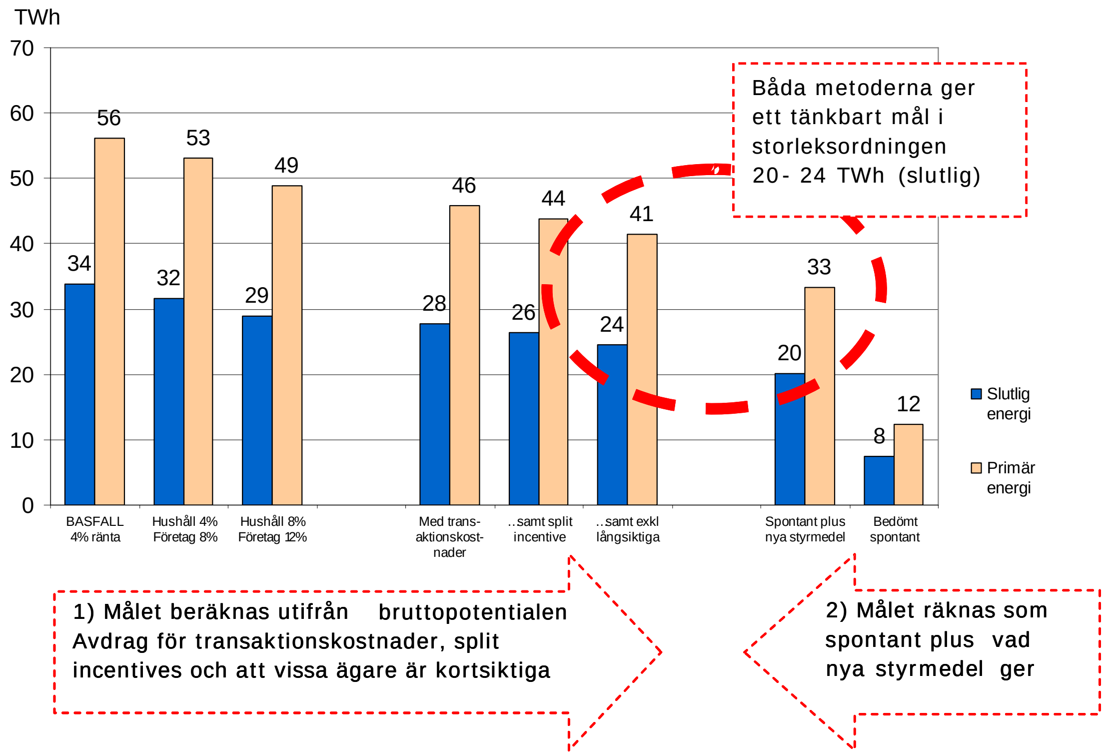
Potentialen vad gäller skärpta energihushållningskrav i *BBR vid ombyggnad* utgår från vår beräkning inklusive transaktionskostnader; kravet på att husägaren skall byta till komponenter med vissa energiegenskaper skall vara lönsamt för denne, och i den kalkylen bör också hans egen tid få inräknas. Potentialen tar hänsyn till hur stor del av beståndet som verkligen gör ombyggnader till 2016.

Det är mycket svårt att bedöma genomslag för det skissade fondsystemet för att stödja *genomförande av energideklarationernas åtgärdsförslag*. Alla åtgärder skall ju vara lönsamma för husägaren (även här har transaktionskostnaderna inkluderats), men givetvis kan denne välja att inte genomföra åtgärderna för att få tillbaka de fonderade pengarna. Vi har grovt antagit, att endast ca hälften av bruttopotentialen faktiskt realiseras. – En förutsättning för att detta förslag skall kunna fungera väl, är att **energideklarationernas genomförandetid förlängs**.

6.6 Underlag för målformulering för sektorn bostäder och lokaler i Sveriges NEEAP

Figuren nedan, från Eneff-utredningen, illustrerar ett sätt att resonera om hur målet för energieffektivisering kan sättas (för bebyggelsen). Dels utgår man från ”bruttopotentialen” (ingenjörsposterna) och reducerar med hänsyn till transaktionskostnader och andra uppenbara och beräkningsbara orsaker till ”effektiviseringsgapet” (se avsnitt 6.4 ovan). Dels utgår man från den spontana utvecklingen och lägger till uppskattad inverkan från de styrmedel som föreslås (se avsnitt 6.5 ovan).

Slutsatsen i Eneff-utredningen är att man i båda fallen hamnar tämligen lika, i spannet 20 -24 TWh slutlig energi (final energy).



7. The EU's target for 20 % improved energy efficiency

In addition to the ESD directive the EU has a target for 20 % improved energy efficiency until the year 2020; a target that is, in principal terms, included in the EU climate change and energy package from December 2008. At present the target for 20 % improved energy efficiency does not include any legally binding targets. In a memorandum published during 2008 (ref. X) the EU presents the prerequisites for this 20 % target. An excerpt from this memorandum is presented below. The memorandum's conclusion is that a clear target for 20 % improved energy efficiency is needed.

7.1 Energy efficiency: delivering the 20% target

European leaders committed themselves to reduce primary energy consumption by 20% compared to projections for 2020. Improving energy efficiency also addresses the key energy challenges of climate change, energy security and competitiveness.

Current energy efficiency legislation alone will not deliver sufficient energy savings to meet the 20% saving objective. Main obstacles to energy efficiency improvements are the poor implementation of existing legislation, the lack of consumer awareness and the absence of adequate structures to trigger essential investments in and market uptake of energy efficient buildings, products and services. The assessment of national energy efficiency action plans shows that there is a gap between the Member States political commitment to energy efficiency and their actions. Member States need to implement more swiftly and effectively energy efficiency legislation. New instruments must be developed to further enhance energy efficiency. For further improvements of energy efficiency in energy supply, the Commission proposes detailed guidelines to facilitate the uptake of electricity generation from high energy efficiency cogeneration installations.

The European Council has underlined the importance of the European framework for energy efficiency policies and measures, i.e. the 2006 European Action Plan for Energy Efficiency, by urging the Commission and Member States to speed up its implementation and consider its possible revision. To this end, the Commission will evaluate this Action Plan in 2009 with a view to prepare a revised Plan.

THE RISK OF FALLING SHORT

EU leaders have stressed the need to increase energy efficiency as part of the '20-20-20' goals for 2020. Both greenhouse gas emission reduction and the renewable targets trigger energy efficiency improvements and, conversely, ambitious action on energy efficiency will greatly help achieve the EU's climate objective. Energy saving is also a crucial asset to ensure EU's security of supply.

'Negawatthours', or avoided energy consumption through savings, have become the single most important energy resource. For example, the annual final energy use would have increased by 115 Mtoe or 11% over the 1997-2006 period had there been no energy efficiency improvements.

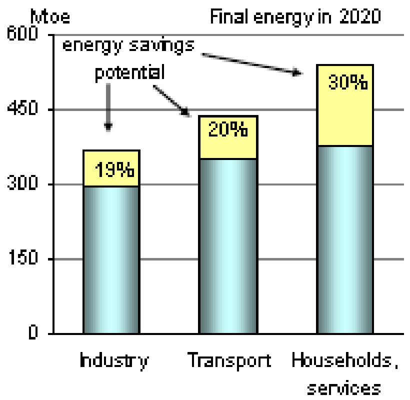
Indeed, on current implementation trends by Member States, it is clear that our saving objective by 2020 is in serious danger of not being met. The first hand information on the evolvement and the implementation as well as other indicators suggest that the energy saving potential is not being realised fast enough. These measures should achieve energy savings of about 13% by 2020 if properly implemented by Member States. Even if this represents a major achievement, **this falls far short of what is needed.**

Expected annual primary energy saving potential by 2020 for EU27 for some specific Energy Efficiency measures (full implementation)

	Measures	Yearly primary energy savings by 2020 compared to 'business as usual' scenario in Mtoe	Yearly primary energy savings by 2020 compared to 'business as usual' scenario in %	Reference document[37]
1	energy services Dir 2006/32/EC	Max 193	Max 9.8%	COM(2008)11(as of 2016)
2	eco-design Dir 2005/32/EC (appliances) and labelling framework Dir 92/75/EC energy star agreement with USA	96 2	4.9% 0.1%	EuP preparatory studies http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm#consultation_forum
3	buildings Dir 2002/91/EC	130	6.6%	SEC(2006)1174
4	cogeneration Dir 2004/8/EC	23	1.2%	COM(2002)415
5	fuel efficiency in road vehicles - CO2&cars –public procurement	36	1.9%	COM(2007)856 & SEC(2007)1723 COM(2007)817
6	urban transport - integrated approach	20	1.1%	Policy assessment of the CIVITAS initiative
	TOTAL NET (taking into account the interplay of measures and the witnessed implementation speed)	256	13%	
	OBJECTIVE EU27 in 2020	394	20%	
	Note: PRIMES model 'business as usual' baseline projections (update 2007) in 2020: EU27 TOTAL primary energy consumption = 1968 Mtoe.			

Recent studies indicate that the opportunities for energy savings still remain significant, as shown in Figure 1.

Figure 1. Estimated energy consumption reduction potential in 2020



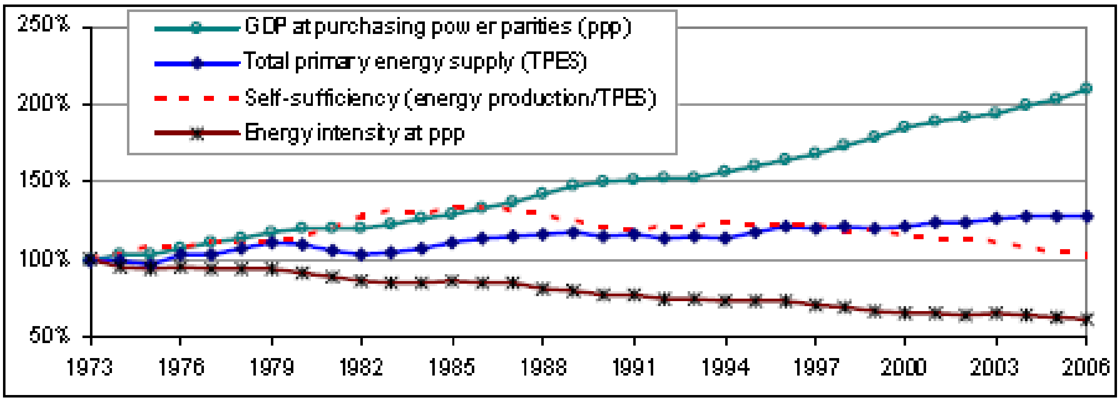
Energy saving potentials by final energy consuming sector and key drivers, actors and barriers for energy efficiency improvements

Sector	Share in final energy cons. (2006)	Saving potential by 2020[13]	Key drivers for energy efficiency	Key barriers	Key actors
All sectors	100%	21%	• Energy policies • Market forces/ energy prices • Financing and taxation • Awareness • Technological development	• Incomplete implementation of energy efficiency legislation • Lack of awareness • Market failures	• Everybody
Households and commercial buildings	41%	30%	• EU and national/regional legal requirements • Technological developments • Financial and fiscal incentives • Energy services Companies • Information instruments (e.g. labelling, certificates, metering, campaigns) • Behaviour trends	• High up-front costs • Owner-tenant dilemma • Lack of awareness on the benefits • Overestimation of the investment needs • No access to attractive financing options • Energy efficiency not recognized as business opportunity	• Property owners and tenants • Construction business • Financial institutions • Consumer associations • National/local authorities • EU institutions
Transport	31%	20%	• EU and national/regional legal requirements • Consumer awareness • Information campaigns • Labelling • High energy prices	• Lack of information • Limited commitment from transport industry • Insufficient infrastructure (e.g. poor urban planning, limited public transport) • Behaviour patterns	• Transport companies • Associations • Citizens • National/local authorities • European institutions
Industry	28%	19%	• High energy and carbon prices • Voluntary and mandatory agreements • Improved energy efficiency of production processes	• High up-front costs • Limited commitment • Low awareness of the benefits • Overestimation of the investment needs • Lack of financing • Low share of energy in production costs	• Companies • Industry associations • National/local authorities • European institutions

With the Green Paper on energy efficiency, the Commission initiated a debate on efficient ways of using energy. The potential to save 20% of primary energy consumption by 2020 in a cost-effective way was recognised. To achieve this, a comprehensive **Energy Efficiency Action Plan** was developed and adopted in 2006. It identifies six key areas14 with the highest potential for energy saving and it proposes 85 actions and measures to be taken at EU and national level. Among them, ten priority actions have been identified and all of these have advanced well.15 The implementation of the Action Plan is ongoing and should be completed by 2012. One third of the actions have been completed but the remainder still need active commitment both at EU and national level.

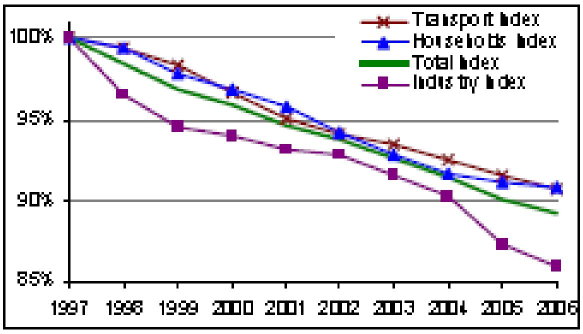
The last decades have seen rapid economic growth which increased our energy needs (see Figure 2 below). While national wealth has more than doubled since the first oil crisis of the 1970s, the energy to support this growth increased only by 30%. Unfortunately, the rate of energy efficiency gains started to slow down in the 1990s and have reduced further in the current decade. Since the 1980s the dependency on energy imports is on the rise again. The EU depends on imports for over half of its energy needs.

Figure 2. Development of some main indicators for Europe (1973 = 100%)19



Within the EU, energy efficiency policies and measures implemented since 1997 together with 'normal' technological progress combined, have contributed to improving final energy efficiency on average by 1.3% per year between 1997 and 200620. Without these gains, final energy consumption would have been 11% higher in 2006. Industry is the sector which achieved the largest energy efficiency improvement.

Figure 3. Energy efficiency trends for final consumers for EU 27 (ODEX index, 1997 = 100%)



There is a lot of room for improvement of energy generation and transmission efficiency.

Development at national level

The Energy Services Directive21 gives a general framework for many saving actions including an indicative energy saving target.22 The Directive applies to energy distributors, distribution system operators, retail energy sales companies, and to all energy users except those covered by the Emission Trading Scheme.

The Directive requires each Member State to submit a National Energy Efficiency Action Plan. These action plans present the national strategy on how to achieve the Directive's energy savings objective.

Almost all Member States have introduced 9% national indicative energy savings target for 2016 calculated in line with Annex I of the Directive. Some Member States have committed to targets that exceed 9%: Italy 9.6%, Cyprus 10%, Lithuania 11%, and Romania 13.5%. This is very positive. Other Member States have indicated that they expect savings from measures to go beyond 9% without committing to the higher target (Luxembourg 10.4%, Ireland 12.5% and the United Kingdom 18%). A number of Member States indicate that the

NEEAPs form part of their strategy to reach the 20% reduction in energy demand by 2020, among them Austria, Ireland and Sweden.

Annex 3 in this document gives a concise assessment of the national action plans. Some of them contain coherent and comprehensive strategies towards the target. Unfortunately, most plans reveal a clear gap between the Member States' political commitment to energy efficiency and the actions they propose. The European Council has requested that the National Energy Efficiency Action Plans be at the core of efforts towards achieving the EU's energy saving objective. Ultimately, the national plans should be the all-encompassing reporting tool for Member States on their energy efficiency policies.

Ongoing measures that qualify as "early action" *(energy improvement measures initiated by the Member State not earlier than 1995 that have a long-lasting effect, which will still lead to energy savings in 2016)* dominate the majority of NEEAPs. Some Member States explicitly indicate the share of savings from early action. In contrast, the NEEAPs of some Member States such as Estonia, Latvia and Poland rely extensively on new measures, though it is difficult to assess whether certain Member States will be able to deliver in accordance with their strategies given the brief descriptions of measures and the absence of saving estimates.

Lessons for the future
The current NEEAPs could play a more important role. National plans will only be effective when they stand for real action: it should set a quantitative, measurable target with a time schedule and concrete steps on who is doing what and the budgetary and human resources available. National plans should require the competent national authorities to work together. Administrative structures should be in place with a clear division of responsibilities. Member States should also ensure that sufficient resources are made available for the promotion of energy efficiency services, information provision and monitoring.

FURTHER ACTIONS: Evaluation of the European Energy Efficiency Action Plan
As foreseen in EEAP in 2006, the Commission will evaluate it in 2009 and prepare a revised Action Plan, as requested by the European Council. The starting points should be the saving potentials and the cost-effectiveness of the policy tools. Energy efficiency must become fully integrated into the broader energy policy, in particular the EU Energy and Climate Package with its dynamic CO_2 and renewable energy policies. The objectives will have to be more demanding in the longer term e.g. 2030 and 2050.

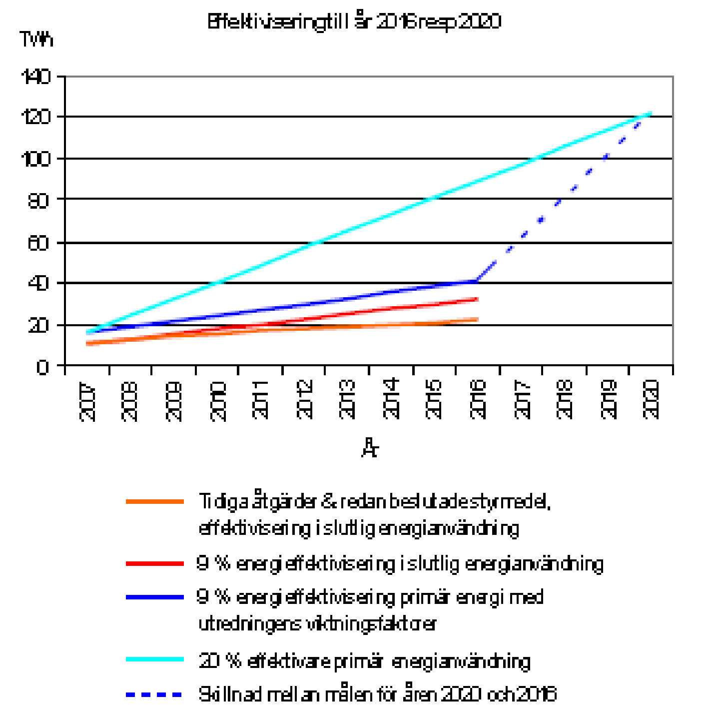
The Plan will focus on energy supply, transmission and energy consumption sectors. The emphasis on the building sector will remain: as more people are living in cities, the latter present a natural opportunity for increased efficiency. Cities also provide possibilities to enhance more efficient urban transport and the use of electric cars. With 23% of total CO_2 emissions coming from road transport, the reduction of vehicles energy intensity and emissions is a major challenge.

CONCLUSIONS
Energy and its use affect us all. Energy efficiency combats climate change, improves energy security, contributes to the attainment of the Lisbon goals, and reduces costs for all EU citizens. Realising energy efficiency gains and at least reaching the 20% energy saving objective must continue to be a priority and the Community's common goal. Policy implementation efforts should be intensified - in particular through the National Action Plans - and the initiatives of this package must be steered swiftly through the legislative process. The proposed measures together with financing incentives, energy taxation and raising awareness will bring about permanent, concrete results.

8. NEP's analyses of the 20 % improved energy efficiency target (excluding transport)

It is a great challenge to go from the ESD directive's target for 9 % improved energy efficiency to the EU's more ambitious target for 20 % improved energy efficiency in only four years (from 2016 to 2020). The illustration from the Swedish EnEff investigation, shown in the figure, clearly illustrates this.

Figur 1.1 Förhållandet mellan direktivets vägledande mål om 9 procent effektivare slutlig energianvändning och 2020 års antagna mål om 20 procent effektivare primär energianvändning i Sverige[12]



It is however, not only the target level and the final year that separates the EU targets for 9 % and 20 % improved energy efficiency. The base year to which the target refers is also different: in the ESD directive (the 9 % target) the base year consists of an average for the first years from 2000, while the base year for the 20 % target is 2020 and a projected level of primary energy use for a "business as usual" scenario for that year.

It is not quite clear in the EU document if the 20 % target, as for the ESD directive, only deals with energy use in plants outside the EU emission trading scheme (EU ETS). In the memorandum presented in chapter 7 above it is indicated that there is an intention to suggest the 20 % target as a complement to the EU ETS. One interpretation of this writing is that it thereby will not affect plants within the EU ETS, but the intention is not 100 % clear.

<u>The NEP choice: In our analyses of the 20 % target in the NEP project we will include the energy use in all plants of the energy system.</u> This may lead to a situation where we analyse a somewhat larger energy efficiency ambition than the EU finally will decide, but we also know that the both other 20 % targets (regarding reduced CO_2 emissions and increased use of renewable energy) also give incentives for reduced primary energy use (e.g. change from coal condensing plants to wind power) Our judgement is therefore that we will not deviate too much from the real development, even if the EU choose to keep the plants within the EU ETS outside the 20 % energy efficiency target.

In the ESD directive it is allowed to, in the 9 %, include measures that have been introduced as a result of earlier energy policies (already decided policy instruments). Among those are for example energy tax, CO2 tax and voluntary agreements. In the EU's document about the 20 % target it is made clear that the member countries will not be allowed in the same manner to include measures that are results of existing policy instruments. It is however not easy to separate which these measures are, at least not in the energy conversion stages. Thus an exact judgement of which measures that requires new policy instruments will be difficult to make. We therefore choose a compromise in the NEP analyses: We exclude measures in the final user stage (measures that decrease "useful energy") for which existing policies give incentives, but include measures in the energy conversion stages for which existing policies give incentives. The primary energy use for these measures in the energy conversion stages are identified through one calculation with the MARKAL-NORDIC model with existing policy instruments and one calculation without these. The impact of these measures is then identified as the difference in primary energy use between the two scenarios.

8.1 How do we move from the 9 % target to the 20 % target in NEP's calculations?

The conclusion from our calculations of the potential in chapter 5, based on the NEEAP's measures for reaching the 9 % target is that there is – in some of the NEEAPs – also an additional potential presented above 9 %, large enough to be able to contribute to reaching a target for 20 % improved energy efficiency (calculated as primary energy use from a "business as usual" scenario for the year 2020).

Our judgement – based on our experience from earlier analyses in the project with the MARKAL model – is that around half of the measures must be measures that actually reduce the useful energy demand. The other half of the measures are to be found in the energy conversion stages, both large scale (e.g. electricity production) and small scale (e.g. local heating of buildings).

8.2 Handling of 20% improved energy efficiency in MARKAL

On the basis of the calculations and considerations that we have presented and discussed in the previous chapters, we have chosen to deal with the 20 % target for energy efficiency in the MARKAL analysis through a number of calculation steps. "The 20 %" are put together in the following way (note that the transport sector is excluded in this analysis):

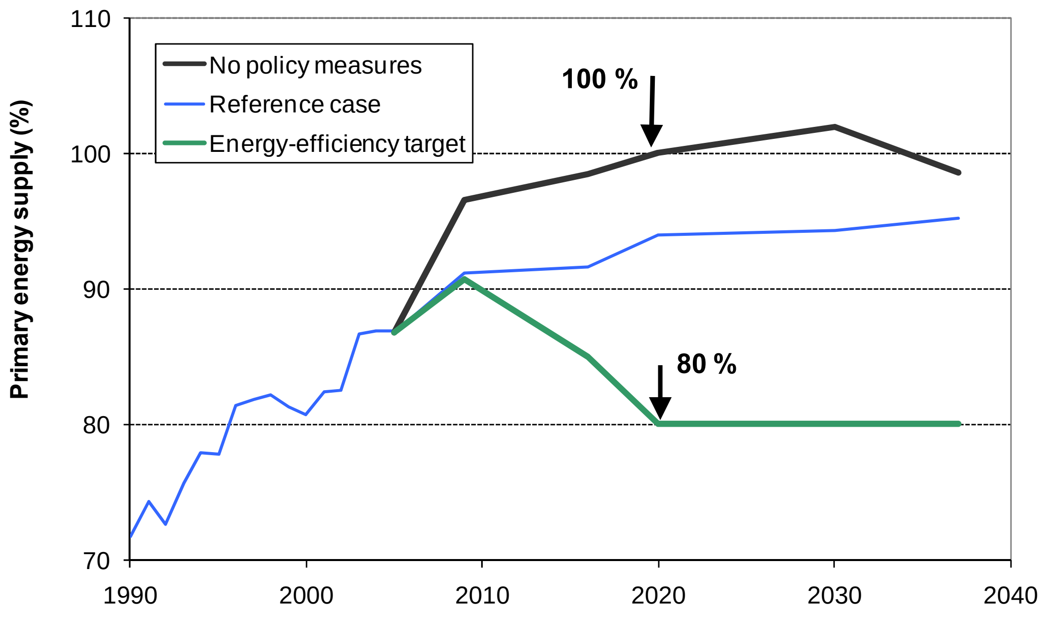
1. The primary energy use (in TWh for the Nordic region) is established. It is then used as the base level for the 20 % target, by means of a MARKAL calculation according to "business as usual", but without the policy instruments that directly influence the size of the primary energy use.
2. The reduction in primary energy for the year 2020, which is caused by the existing policy instruments influence on the energy conversion stages, is then calculated through a comparison of total primary energy in the "business us usual" scenario with a scenario that includes existing policy instruments (the reference scenario).
3. After that, the primary energy reduction caused by the existing policy instruments is then recalculated into per cent (x %) of the base level (established in step 1 above) and the target level for new measures is then identified.
4. Then a reasonable potential (y %) for useful energy measures is calculated/established. The potential is founded on the conclusions and discussions in the chapters 5 – 6 above (see also calculations/tables below). In the MARKAL calculations the assumed useful energy demand is reduced by y %.
5. Thereafter we let MARKAL identify measures in the energy conversion stages in scenarios target / boundary condition to reduce primary energy use by z %, where z % = 20 % - x % - y %.

6. In all scenarios nuclear energy is primary energy weighted by one (1) (see discussion on primary energy weighting below).
7. Finally a quality control is made by comparing the marginal costs in the useful energy stage and the energy conversion stages (and possibly adjusting the y % term up/down).

8.3 Calculation of base level and the effect of existing policy instruments

By means of the MARKAL model we establish the primary energy use (in TWh for the Nordic energy system) that will form the base level for the 20 % target, through model calculations for a "business as usual" scenario, but without the policy instruments that directly influence the size of the primary energy use. The figure below shows that the base level can be found at approximately 15 % above the 2005 primary energy use level.

The definition of the energy efficiency directive that prescribes 9% more efficient use of energy until 2016 allows that the member countries credit themselves with the improved energy efficiency which is brought about by already implemented policy instruments. In the same way we – with MARKAL Nordic – have calculated what primary energy reduction is achieved by today's policy instruments in the Nordic countries until 2020, by comparing the primary energy use in the reference case to the case without policy instruments. The comparison shows that today's policy instruments decrease primary energy by about 5%. (The term which we in the chapter above named x % is thereby for the Nordic energy system equal to 5 %.)



The remaining 15% energy efficiency must therefore be achieved through "new" policy instruments.

How, then, do we reach 15% improved energy efficiency in the Nordic countries?

(An important experience from the MARKAL analyses with the two other 20% targets is that the CO2 target plus the renewability target reduces the primary energy use by around 5% to 2020, compared to the primary energy use in the reference case.)

8.4 Calculation of a reasonable potential for efficiency measures in useful energy

The table to the right summarizes the potential that we have considered to be reasonable for useful energy measures in the housing and service sector and in the industry sector (non EU ETS industries) in the Nordic countries by the year 2020. The potential calculated as "final energy" is 8.0 % and calculated as primary energy it is approximately 11 %.

The term which we in the chapter above named y % is thereby for the Nordic energy system (excluding the EU ETS industries) equal to 11 %. If we include the primary energy use in the EU ETS industries, y is equal to 8-9 %.

The calculation is based on the potential that we identified in chapter 5 above.

Alla sektorer - Norden	**Norden**	
Relativt BaU-2020	Läge 2020	Läge 2020
	Final energy	Final energy
Energianvändning basår	**765**	
Effektiviseringsåtgärder - el	23,1	3,0%
Effektiviseringsåtgärder - värme	**37,9**	**5,0%**
Summa (inkl. MARKAL-åtg)	**61,0**	**8,0%**
Bostäder och servicelokaler		
	Läge 2020	Läge 2020
	Final energy	Final energy
Energianvändning basår	**429**	
Effektiviseringsåtgärder - el	16,0	3,7%
Effektiviseringsåtgärder - värme	**24,8**	**5,8%**
- ökn/minskn av åtg. jmf. med NEEAP		
Summa	**40,8**	**9,5%**
Industri		
	Läge 2020	Läge 2020
	Final energy	Final energy
Energianvändning basår	**336**	
Effektiviseringsåtgärder - el	7,1	2,1%
Effektiviseringsåtgärder - värme	**13,2**	**3,9%**
- ökn/minskn av åtg. jmf. med NEEAP		
Summa	**20,2**	**6,0%**

In the table on the next page the potential country by country is shown.

When we have calculated the potential we have followed a number of steps, through which we have converted the potentials from the NEEAPs to data for MARKAL, for the analysis of the 20 % improved energy efficiency target:

1. We have started out from the potential that we calculated from, among others, the NEEAPs in chapter 5 above.
2. We have divided this into heat and electricity savings.
3. We have updated the base year to 2020 and calibrated against final energy demand in the different countries and sectors of the MARKAL reference scenario (and also checked against the modified reference scenario where the existing policy instruments are excluded).
4. We have made simplified estimations in order to increase or decrease the NEEAP potentials, in a way that the "efforts" in the different countries are equalised to a greater extent.
5. We have excluded the transport sector, which is not included in the MARKAL calculations. This sector is, however, analysed in another NEP report.

6. We have finally "balanced" the whole potential to reach approximately 10 % energy efficiency of the primary energy use through measures in the final energy use stage. (The remaining 10 % are measures in the energy conversion stages.)

In the table below the potential is shown country by country.

Alla sektorer - Norden	**Norden**		**Sverige**		**Danmark**		**Finland**		**Norge**	
Relativt BaU-2020	Läge 2020	Läge 2020	2020	2020	2020	2020	2020	2020	2020	2020
	Final energy	Final energy	TWh	%	TWh	%	TWh	%	TWh	%
Energianvändning basår	**765**		**294**		**130**		**165**		**177**	
Effektiviseringsåtgärder - el	23,1	3,0%	9,3	3,2%	3,3	2,6%	2,6	1,6%	7,8	4,4%
Effektiviseringsåtgärder - värme	**37,9**	**5,0%**	**13,8**	**4,7%**	**9,0**	**7,0%**	**9,2**	**5,6%**	**5,9**	**3,4%**
Summa (inkl. MARKAL-åtg)	**61,0**	**8,0%**	**23,1**	**7,9%**	**12,4**	**9,5%**	**11,8**	**7,2%**	**13,8**	**7,8%**
Bostäder och servicelokaler										
	Läge 2020	Läge 2020	2020	2020	2020	2020	2020	2020	2020	2020
	Final energy	Final energy	TWh	%	TWh	%	TWh	%	TWh	%
Energianvändning basår	**429**		**156**		**84**		**93**		**97**	
Effektiviseringsåtgärder - el	16,0	3,7%	6,9	4,4%	2,3	2,7%	2,0	2,2%	4,8	5,0%
Effektiviseringsåtgärder - värme	**24,8**	**5,8%**	8,2	**5,3%**	6,6	**7,9%**	6,0	**6,5%**	3,9	**4,1%**
- ökn/minskn av åtg. jmf. med NEEAP										
Summa	**40,8**	**9,5%**	**15,1**	**9,7%**	**8,9**	**10,6%**	**8,0**	**8,6%**	**8,8**	**9,1%**
Industri										
	Läge 2020	Läge 2020	2020	2020	2020	2020	2020	2020	2020	2020
	Final energy	Final energy	TWh	%	TWh	%	TWh	%	TWh	%
Energianvändning basår	**336**		**138**		**46**		**72**		**80**	
Effektiviseringsåtgärder - el	7,1	2,1%	2,4	1,7%	1,1	2,3%	0,6	0,9%	3,0	3,8%
Effektiviseringsåtgärder - värme	**13,2**	**3,9%**	5,6	**4,0%**	2,4	**5,3%**	3,2	**4,4%**	2,0	**2,5%**
- ökn/minskn av åtg. jmf. med NEEAP										
Summa	**20,2**	**6,0%**	**7,9**	**5,8%**	**3,5**	**7,6%**	**3,8**	**5,3%**	**5,0**	**6,3%**

8.5 Calculation of energy efficiency of the energy conversion stages by means of MARKAL

The remaining efficiency measures (z %) is identified by MARKAL in the optimization. The result from the model runs in spring 2008 shows that MARKAL chooses around half of these efficiency measures as "substitution in R&C and industry" (e.g. change from electrical heating to heat pumps in small houses) and the other half as efficiency measures in "measures in the large-scale energy conversion" (e.g. more electricity produced in cogeneration plants instead of production in condensing plants).

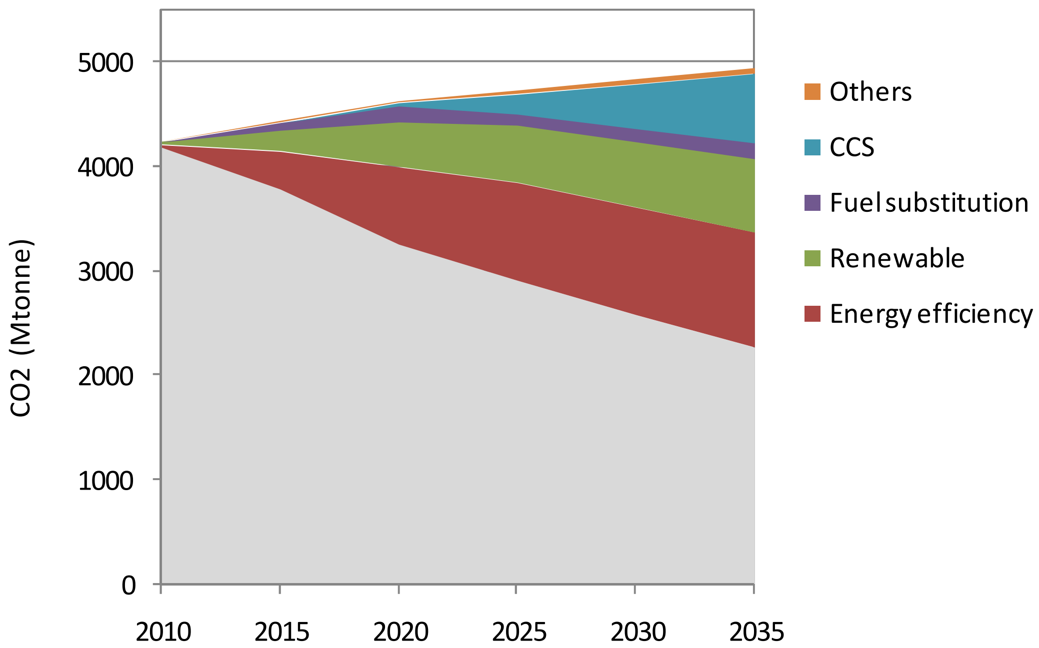
Primary energy weighting

Since the EU's energy efficiency target relates to primary energy the primary energy weighting is important for the MARKAL calculations. We have weighted all types of energy by the factor one (1), with the exception of the free heat energy which is utilized in heat pumps, which has been weighted by zero (0). When it comes to nuclear power we have weighted the electricity out from the power plants by the factor one (1); we have thus not weighted nuclear power by the uranium energy value as basis for primary energy. In the EU there is an ongoing discussion about how nuclear power should be weighted.

If nuclear power is primary energy weighted from the uranium energy content point of view, a phasing out of nuclear power becomes a cost-effective "energy efficiency measure" shows earlier MARKAL analyses in NEP. This is not a desired development since nuclear power is free from CO_2 emissions (at least in the energy conversion stage) and since we do not believe that the purpose of the energy efficiency target is phasing out nuclear power. In the EU's climate change and energy package nuclear power is instead presented as an important measure for reduction of CO2 emissions.

The reason for why we here want to put a climate perspective on the primary energy weighting of nuclear power is thus that increased energy efficiency from an EU perspective to a large extent is a CO2 matter (and thus not only a matter of resource management). Without improved energy efficiency it is not possible for the EU to reach its 20 % CO2 emission target for the year 2020. This has for example been shown through analyses with the Primes model. Energy efficiency is one of the EU's most important CO2 reduction measures. If then an energy efficiency target is formulated (and a high primary energy weighting of nuclear power is applied) in a manner that phases out nuclear power – with no CO2 emissions from the energy conversion – would be contra productive for the EU from a CO2 point of view. This could not "be afforded" and our conclusion is therefore that it could not be the purpose of the EU.

The figure below shows how the EU could/will fulfil its CO2 commitment (– 20 %) for the year 2020 (followed by continuing CO2 reduction). The figure is a first, very preliminary, result from the Pathways project (Chalmers University of Technology), for a scenario where the EU chooses not to focus on fuel switching from coal to natural gas, but instead put lot of efforts into renewables and energy efficiency. As shown in the figure energy efficiency is a very important CO2 measure. (Please note that the figure includes all sectors, also the transport sector).



9. Results from model analyses with the MARKAL model

The MARKAL analyses show that the energy efficiency acquires a key role in the energy changeover when the EU's three 20% targets are implemented:

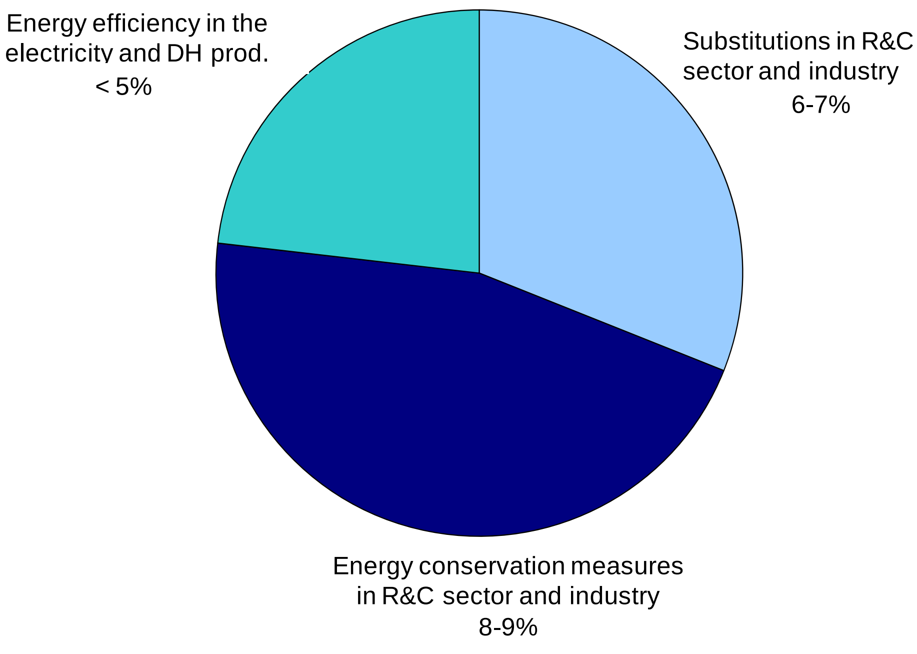
- 20% energy efficiency – efficiency measures throughout the entire energy system may be exploited
- 20% decrease of emissions of greenhouse gases – mainly carbon dioxide
- 20% renewable share in the EU energy mix – increase by about 10% in the Nordic countries

MARKAL results for the Nordic energy system for 2020 show that the energy efficiency gives both resource conservation and CO2 reduction, at the same time as the improved energy efficiency contributes to increasing the renewable share in the energy system. But our judgement is that relatively great (political) "incentives" are needed in order to realize the efficiency potential.

The menu of efficiency measures

The result from the up-dated model runs shows that MARKAL chooses around 6-7% efficiency measures as "substitution in R&C and industry" (e.g. change from electrical heating to heat pumps in small houses) and 5% as efficiency measures in "measures in the large-scale energy conversion" (e.g. more electricity produced in cogeneration plants instead of production in condensing plants).

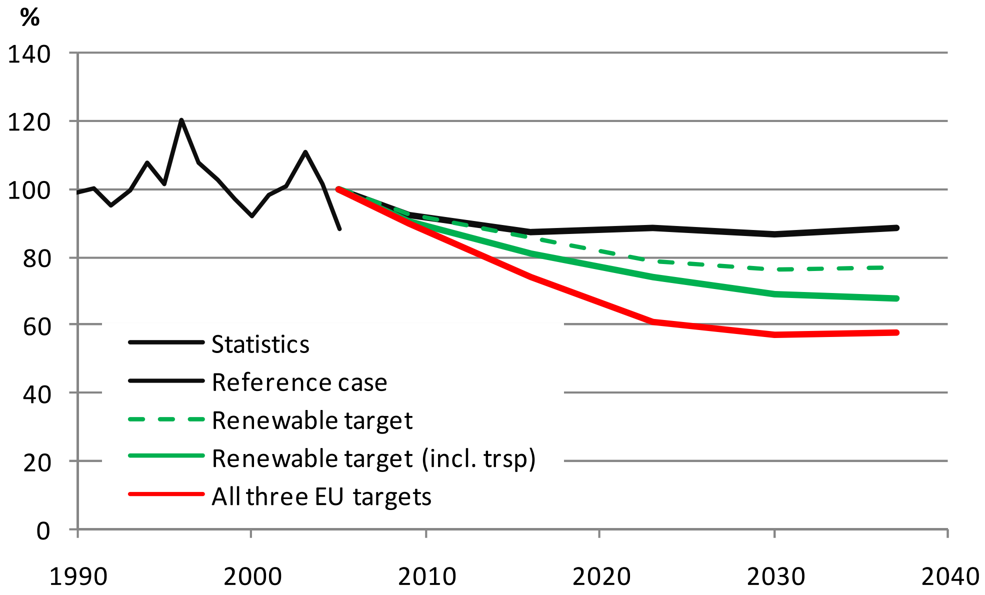
If we include the 8-9 % conservation measures in R&C sector and industry from the tables above, the entire "menu" of efficiency measures to reach the 20% targets will be as shown in the figure below.



The menu of measures to achieve 20% improved energy efficiency in the Nordic countries

9.1 Around 40% CO_2 reduction in the Nordic energy system

The EU's targets of at least 20% renewables in the energy mix, and a decrease of energy use by 20% through efficiency measures, become powerful instruments also for decreasing the carbon dioxide emissions. The model calculations show that the two 20% targets together decrease the carbon dioxide emissions from the Nordic energy system (excluding transports) by all of 40%.



The carbon dioxide emissions from the Nordic energy system in different scenarios

Thus, in the model runs, the EU targets are fulfilled as regards a decrease of carbon dioxide emissions by 20% until the year 2020 without needing any special policy instruments for reduction of greenhouse gases. At the EU level the targets of renewability and efficiency use of energy have arisen largely to "back up" the emission-reduction target. But the model analyses conducted for the Nordic countries show that those two targets lead to an influence on the trend which clearly *exceeds* the emission target's effects on the Nordic level.

9.2 MARKAL runs

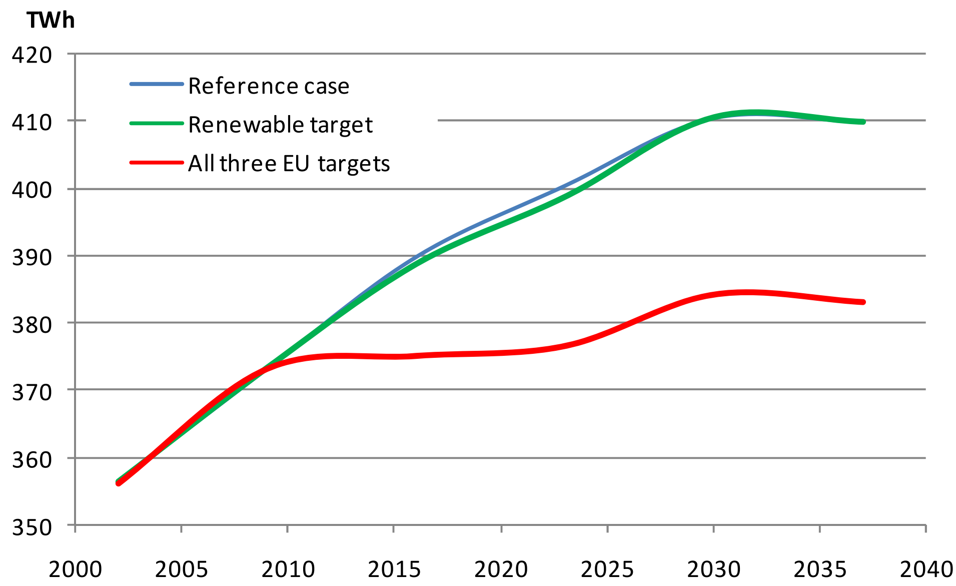
We have analyzed the following scenarios with MARKAL Nordic:

1. Reference case ("business as usual")
- Energy use according to STEM's reference case
- Today's policy instruments and other political decisions
- Not the EU's three 20% targets (nor e.g. 9% efficiency target)

2. EU 20-20-20 until 2020
- Energy use according to STEM's reference case
- Today's policy instruments and other political decisions
- All the EU's three 20% targets (and e.g. 9% efficiency target)
- Primary energy weighting on nuclear energy of 1 (instead of 3)

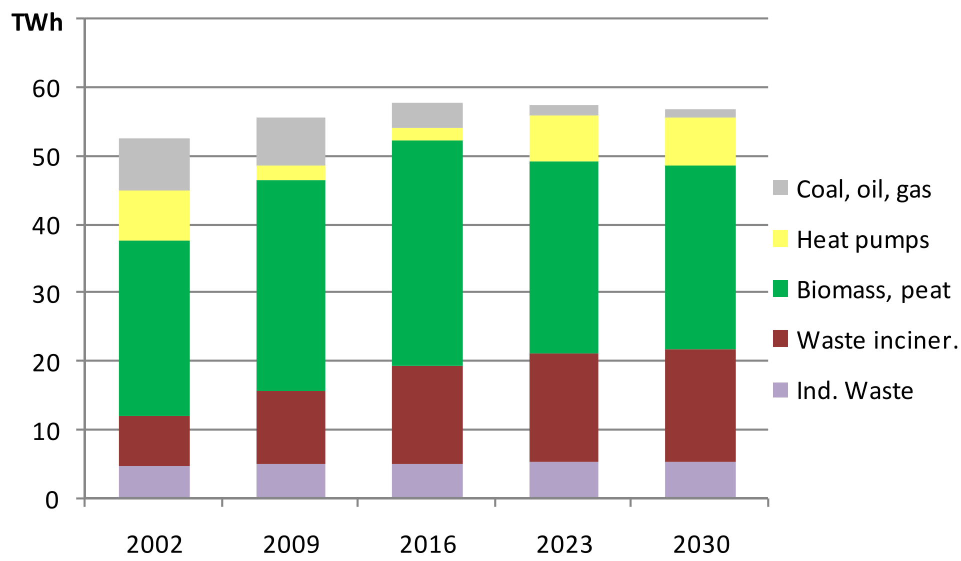
9.3 Decrease in use of electricity and district heating in the Nordic countries

The efficiency target has also a clear impact on electricity use in the Nordic countries. From the figure below, we can see (in the results for the renewable target scenario) that neither the CO2 target nor the renewability target influences the electricity use (in comparison with the electricity demand level in the reference case). In contrast, in the scenario with all three targets, the decrease is 25-30 TWh for the model years after 2020.



The electricity demand in the Nordic countries for different scenarios. The reference case also includes the EU ETS system. The renewable target scenario also includes the CO2 target.

A 20% efficiency improvement also has a clear effect on the heating market. The figure below shows the trend for Swedish district heating. In the reference case, district heating increases by 5-10 TWh between the model years 2009 and 2023, but in the scenario with all three targets it does not increase at all.



District heat production in Sweden in the scenario with all three targets.