Achieving energy savings in the residential and service sector: A challenging case study of the potential and costs for the Netherlands

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Abstract
The Green Paper on Energy Efficiency introduces an additional energy saving target of 20 % until 2020. At the same time, the Dutch parliament demands an overall speed of energy saving of 2 % a year until 2020. Both targets imply an ambitious increase in saving efforts. This paper focuses on the Dutch residential and services sectors. It includes an inventory of technical and behavioural saving measures that may contribute to energy savings by reducing heat and electricity demand or by increasing conversion efficiency. This paper also provides an inventory of barriers, such as costs and institutional barriers, which inhibit the application of these saving measures. In order to assess the feasibility and cost of reducing energy use, the paper analyses the capability of policy instruments to overcome these barriers. The combined analysis of measures, barriers and policies does not only help to determine the feasibility of achieving various energy saving targets, but also to determine the overall cost involved. Finally, the yearly saving percentages feasible in both sectors are analysed for different upper limits on the acceptable cost per tons of abated CO_2.

Introduction
In the Netherlands, the present pace of energy saving is 1 % per year. Saving energy is a means to achieve other goals, such as increasing security of supply, reducing CO_2 emissions and reducing dependency on fossil fuels. Both at European and national level, pressure exists to increase this pace. The Green Paper on Energy Efficiency introduces an additional energy saving target of 20 % until 2020[1] and the Dutch parliament demands an overall saving speed of 2 % per year from 2010 until 2020[2]. Both targets imply an ambitious increase in saving efforts. This paper analyses what instruments the Dutch government can introduce to realise 2 % of savings per year and how high the related costs are for the government and for the Dutch residential and services sector.

Methodology
The total technical saving potential is analysed, relative to the baseline scenario 'Global Economy – High oil Prices[3]' (GEHP) (Daniëls and Farla, 2006). The baseline scenario contains existing policies and policies planned in December 2005. To determine the effect of an increase in energy saving pace, 'energy saving' will be defined first. In the Dutch 'PME[4]' saving is defined as "reducing energy use, while the same activities are carried out or the same functions are realized with less energy". RES do not contribute to energy savings according to the PME definition. According to the definition in the PME, total en-

1.This means a saving of 2.7 % per year (Doing more with Less, Action Plan for Energy Efficiency, 2006)

2. This saving target is the result of a motion of Van der Ham/Spies, which has been accepted in the spring of 2005. The motion targeted a gradual increase of the annual energy efficiency in the Netherlands of the present saving pace of 1 % (Gijsen, 2006) to 2 % in the period 2005-2010. In the period 2011-2020 the saving pace is aimed to be 2 % per year. This will lead to an additional saving of 475 PJ in the period 2005-2020, relative to the GEHP baseline scenario.

3. with oil prices of 40 dollar/barrel (2 000 US$).

4. Protocol Monitoring Energiebesparing- A Dutch document that describes the methodology of how energy saving pace should be calculated in the Netherlands (www.energie.nl)

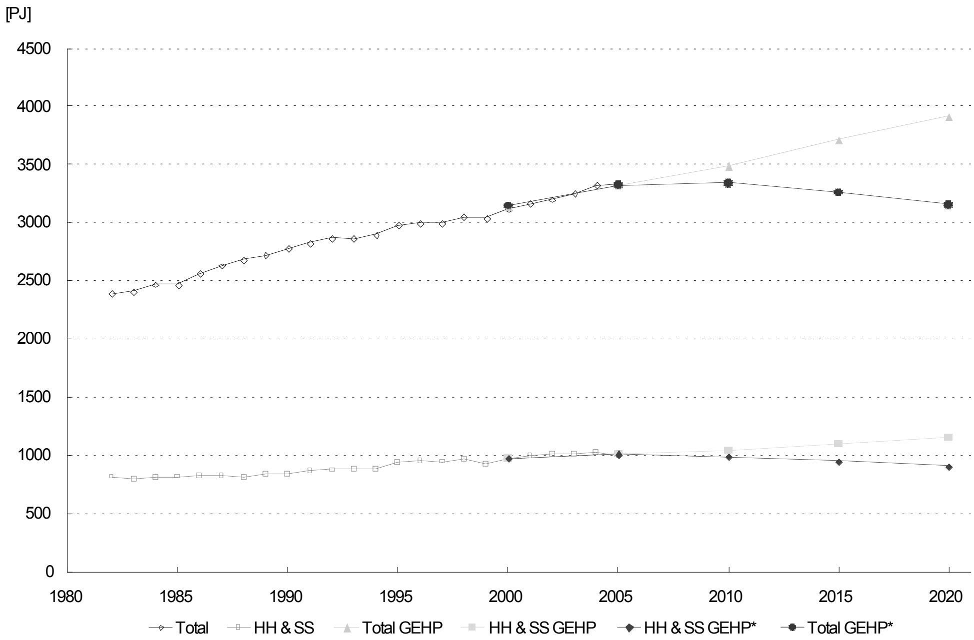

Figure 1 Energy use in the Netherlands, baseline scenario (GEHP) and scenario with maximum reduction (GEHP) for all sectors in the Netherlands (total) and the residential and services sector (RS&SS)*

ergy savings of 595 PJprim can be realised in the Netherlands in 2020, relative to the GEHP scenario. In this paper, the definition of 'energy savings' will be less strict, because renewable energy behind the meter (such as solar thermal water heaters and heat pumps) is also considered to be energy saving.

Saving potential

According to the 'broader' definition of energy savings, 760 PJprim can be saved by 2020, relative to the baseline scenario (see Figure 1). This total saving potential is the sum of all the maximum achievable saving potentials[5] described in the Optiedocument (Daniels and Farla, 2006). The Optiedocument reports on the technically feasible saving potentials of different options, based on a large number of sources[6]: Dril, A.W.N. van, et al. (1999), Dril, A.W.N. van en H. Elzenga (2005), Graus, W.H.J., S. Joosen (2003), Harmelink, M. en K. Blok (2004), Harmelink, M. et al. (2005), Joosen, S. et al.(2004),and Menkveld, M. et al. (2005). The potential shown in Figure 1 is the maximum potential, taking into account not only technical barriers but also barriers to the effectiveness of policy instruments[7]. At national level, (all sectors included) a saving pace of 2.1 to 2.2 % per year can be realised. In the built environment (residential and services sector) a saving pace of 2 % per year can realised, but only at high cost (see Table 1) and under the condition of setting standards (Daniëls et al., 2006).

Saving measures and costs

Table 1 shows the saving potential in the residential and service sector in more detail. In total 248 PJ can be saved in these sectors, which is one third of the total savings that can be realised in the Netherlands. Large savings are possible especially by 'heat demand reduction in existing dwellings (43 PJ), 'electricity savings by changing behaviour or higher efficiency of appliances' (79 PJ) and 'electricity savings bound to building and of office equipment' (53 PJ). Of these options, the latter has negative national costs per ton of abated CO_2. In general, the cost per ton abated CO_2 is high (> 100 euro/ton) relative to cost in other sectors such as industry and transport.

Barriers to savings

In table 1 two types of costs are defined, national costs and end user costs[8]. Part of the options in table 1 have negative end user costs, which means that the yearly energy savings exceed the yearly investments costs. In spite of the negative end user costs in table 1, these options are not realized currently and in the baseline scenario. Apparently there are barriers other than financial ones, preventing these options from being realized. An overview of the barriers is shown in table 2[9].

5. Only the saving potentials that fit the 'broader' definition of energy savings used in this study.

6. Only sources that has been used for determining the saving potential of at least two different options are named, for a more extensive list see http://www.ecn.nl/nl/ps/onderzoeksprogramma/nationaal-klimaatbeleid/optiedocument-20102020/ (factsheets)

7. For example, if the government wants to increase insulation in dwellings, it can require a minimum energy performance when a house changes owner/tenant. However, this policy measure will only affect the dwellings that change owner/tenant up to 2020. The effectiveness of the standard will therefore be less than 100 %.

8. National costs are yearly societal costs for 'the Netherlands'- This provides an indication of the net cost (all costs and savings subtracted from each other), based on the national discount rate of 4 % and world market energy prices. End user costs are yearly costs for the relevant sectors, without additional costs and savings due to changes in policies. This provides an indication of the net costs (all costs and savings subtracted from each other), based on the discount rate of the relevant sector (5,5 % for residential-8 % for the service sector) and on end user prices, existing levies included.

9. Split incentives: An example of split incentives are buildings rented by companies and households, for which energy costs are not included in the rent. This means that the building owner should invest in energy saving measures, while the renters will get the financial benefit.

Table 1 Overview of technical saving potential and costs (policy excluded), for residential and service sector

Saving option	Savings (PJ)	National costs (mln euros/yr)	End user costs (mln euros/yr)	Savings of CO_2 (Mton/yr)	National costs (euro/ton)
Existing dwellings – residential sector	48	641	181	2.7	237
Solar boilers	2	123	104	0.1	951
Heat demand reduction by economical heating behavior	3	-19	-59	0.2	-104
Heat demand reduction existing dwellings	43	537	135	2.4	224
New dwellings – residential sector	**10**	**531**	**536**	**0.5**	**1123**
Heat demand reduction new dwellings	4	399	419	0.2	1779
Heat pumps in new dwellings	6	132	117	0.2	532
Appliances – residential sector	79	261	-1333	5.7	46
Electricity saving by changing behavior or higher efficiency of appliances	79	261	-1333	5.7	46
New conversion technologies – residential sector	6	425	343	0.4	1034
Condensing boilers with higher efficiency	3	299	286	0.2	1776
Micro-CHP	3	126	58	0.2	519
Existing buildings – service sector	44	428	259	3.1	139
Small scale CHP	13	55	-113	1.2	47
Electricity reduction – (building related)	11	-12	-120	0.8	-15
Demand reduction existing buildings	20	386	491	1.1	344
New buildings – service sector	7	337	474	0.4	942
Demand reduction new buildings	3	339	483	0.2	1775
Heat pumps	3	-15	-25	0.2	-100
Solar boilers	0	14	15	0.0	819
Appliances – service sector	53	-58	-574	3.9	-15
Electricity savings bound to building and of office equipment	53	-58	-574	3.9	-15
New conversion technologies – service sector	**2**	**38**	**27**	**0.2**	**231**
New concepts small scale CHP	2	38	27	0.2	231
Total	248	2604	-87	16.8	155

Source: based on (Daniels and Farla, 2006)

Table 2 Overview of the different barriers and the relevant actors

Name group	Barriers	Relevant actors
Existing dwellings – residential sector	Lack of attention, split incentives	Dwelling owners- residents, large social and commercial lessors, small private lessors, households
New dwellings – residential sector	Conservative attitude in a large part of the construction sector, split incentives	Project developers, construction companies, (mortgage) banks, communities
Appliances – residential sector	Lack of insight and attention, split incentives	Producers of electric appliances, households
New conversion technologies- residential sector	Availability of new technologies	Construction companies and contractors, dwelling owners
Existing buildings – service sector	Attention, split incentives	Companies with their own building, commercial lessors
New buildings – service sector	Conservative attitude in a large part of the construction sector, split incentives	Project developers, construction companies
Appliances – service sector	Lack of insight and attention, split incentives	Producers of electric appliances
New conversion techno-logies – service sector	Availability of new technologies	Construction companies, building owners

Based on (Daniels et al., 2007)

Policy instruments

For each group of barriers, policy measures need to be implemented to overcome these barriers. In order to make policies efficient and feasible, three conditions are defined for the policy measures. First of all, they should be directly targeted at the relevant actors, if possible directly at decision moments, so that no unnecessary extra costs are introduced and no potential will be lost. Secondly, they should have a relation with existing policy if possible, which will facilitate quick introduction. And finally, policy should be designed at a national level as the aim of this report is to determine what policies the Dutch government can introduce to realise 2 % saving per year[10].

10. Policy should only be designed at a European level, if it is difficult to influence

Table 3 Instruments per group of saving options (Reference: Daniels et al. 2007)

Name group	Instrument packages
Existing buildings – residential (rs)/ service sector (ss)	**Setting standards** (rs/ss): energy standard based on EPBD energy performance certificate. The level of the standard should at least be equal to current average energy use of buildings in the sector. **Financial support** (rs – dwelling owners): take total living costs into account in mortgages (efficient house has lower energy costs, so higher (monthly costs for) mortgage is feasible). (rs – dwelling lessors): change the rent system, so that energy improvements of the dwelling can be calculated in the rent. (ss – companies): fiscal advantages for companies in energy efficient buildings and higher energy tax to improve the feasibility of small CHPs.
New buildings – residential (rs)/ service sector (ss)	**Setting standards** (rs/ss): stricter energy standards in 2012 and 2015 (chosen to realise stricter standards in two staps, so that construction companies have enough time to adjust their way of working to the stricter standards) Construction standards (high insulation, heat recovery systems, etc) **Financial support** (rs – dwelling owners): take total living costs into account in mortgages (efficient house has lower energy costs, so higher (monthly costs for) mortgage is feasible) (rs – project developers): municipality should allow higher maximum house prices for more efficient houses. (ss – companies) fiscal advantages for energy efficient buildings
Appliances – residential (rs)/ service sector (ss)	**Setting standards** (rs/ss) Absolute standards at EU level for the energy use of appliances/ office equipment in active and stand-by modus. **Financial support** – not needed
New conversion technologies – residential (rs)/ service sector (ss)	**Setting standards** (rs/ss) Up to 2020 no standards for these technologies (micro CHP/ condensing boilers with an integrated heat pump/small scale CHP). Stimulating market penetration is more important **Financial support** (rs): subsidies of the additional costs compared to condensing boilers for the first 50.000 samples of both technologies. (ss): – no support needed

Often packages of instruments are more effective than a single instrument. Most packages consist of one or two instruments which are needed to realise the saving potential (often regulation and/or a strong financial incentive). Supporting/soft instruments (such as information) can enhance the effect of the other instruments, so that these can be designed less strictly. Table 3 shows the standards and financial support for the different groups of saving options. [11]

An example of practical support is to set up one counter for all practical and financial matters for energy efficient renovation of dwellings (support for households). Other forms of practical support are the implementation of 'smart meters' in all dwellings to raise consumers' attention to energy use or to stimulate the foundation of ESCO's which deliver energy services. Financial support for large scale pilot projects (for new conversion technologies) and introducing quality standards/ certification so that the image of new conversion technologies will only be determined by efficient technologies are other examples of practical support.

Amongst all group of instruments in table 3, standards are suggested to realise the saving potential. Standards are the most direct way to realise the saving potentials. Another advantage of setting standards is that all responsibility for energy savings is removed from households and companies, which form a very large and diverse group. By setting standards, the number of actors that have to fulfil these, has strongly reduced which facilitates the communication and control of the standards.

Feasibility of saving targets

In defining the saving potentials of table 1, it has already been taken into account that not the whole technical potential can be realized. One example is the impossibility to convince all inhabitants of the Netherlands to change their heating behaviour in their houses. Therefore only a part of the existing potential will be realized. Another example is the potential of existing buildings. When selling/renting a building, it is proposed that a minimum energy performance should be realized. Buildings that do not change owner/renter in the period 2007-2020, will not be required to fulfill a minimum energy standard. In this case the instrument limits the opportunities of saving energy.

Overall costs

Table 4 gives an overview of maximum savings[12] (see table 1), and the related national and governmental costs. Government costs consist of subsidies (discounted to yearly costs) and of implementation costs (costs of personnel, costs of overhead), etc. Implementation costs are only determined on an abstract level. The packages need to be worked out in more detail before implementation is possible. Different detailed designs can lead to different yearly costs. Thus, the implementation costs are only a rough estimation of the real costs[13].

Table 4 shows that more than half of the possible savings can be realised by reducing energy use of appliances and office equipment. These are also the cheapest saving measures, both at national level and for the government. The specific costs of

the relevant actors with national policy.

11. The EPBD energy performance certificate: The Energy Performance Building Directive requires that, when a house/building changes owner or tenant, a certificate can be shown, containing among others an indication of the energy performance of the building.

12. Realised with the instrument packages from table 3.

13. Uncertainty about implementation costs is also a consequence of estimating the future implementation costs on the basis of current implementation costs (which are often difficult to determine).

Table 4 Savings and costs to implement 2 % energy saving in the residential and service sector

Package	Savings [PJ_{prim}]		National costs (policy excl.) [mln euros/year]		Governmental costs for additional policies from table 3 [mln euros/year]	
	RS	SS	RS	SS	RS	SS
Existing buildings	48	44	641	428	177	122
New buildings	10	7	531	337	141	57
Appliances/office equipment	79	53	261	-58	0	0
New conversion technologies	6	2	425	46	29	2
Total	143	106	1858	754	347	125

Source: (Daniëls et al., 2006)

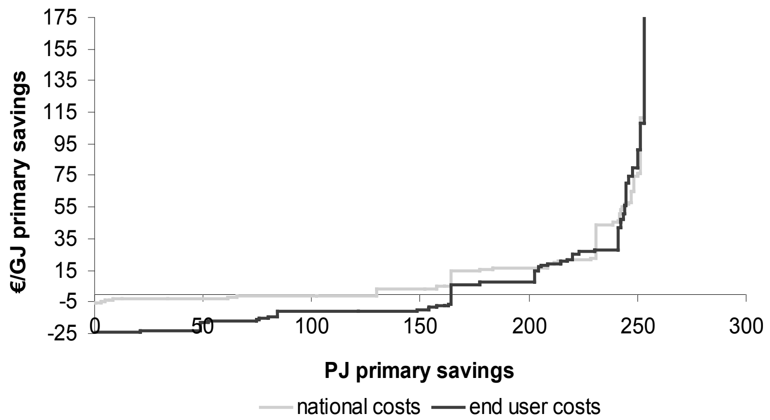

Figure 2 Costs curves for the residential and service sector (source: Daniels et al., 2007)

these saving measures (euro/GJ_{prim}) are actually the lowest of all measures in table 4.

Limits of acceptable costs per tons of abated CO_2

Figure 2 shows the specific costs and the contribution to the total savings in the built environment for all saving measures. Large variations of specific costs can be noticed in figure 2, varying from -25 Euro/GJ_{prim} up to 125 Euro/GJ_{prim}. Even higher specific costs occur, but they hardly play a role, as they represent only a very small potential. The oil prices have only a very small effect on the specific costs, as commodity prices are only a small component of the total energy prices in the built environment.

The analyses for the built environment have also been carried out for other sectors: i.e. industry, electricity production, agriculture and transport (Daniels et al, 2006). The built environment is responsible for a considerable part (about 75%) of the total national cost (3 475 mln Euros/year) needed to realise 2 %/year. In this total, the costs for additional policy are not included, as these are often very uncertain (Daniëls et al, 2006).

Conclusion

If a saving pace of less than 2 %/year is acceptable, costs of energy saving may reduce considerably, as the saving measures with the highest specific costs become superfluous. The measures with high specific costs are often construction-related measures. From the point of robustness, construction measures with a long lifetime are preferred over savings by electric appliances (which have a lifetime of about 10 years). If standards will be replaced by White Certificates, financial instruments and/or convenants, the energy savings will reduce considerably.

The saving potential of the options in table 1 is calculated under the assumption that in 2005 it had aready been decided to implement new policies. Then the first savings could be realised in the period 2007-2008. If instead of 2005, the policy options are implemented in 2007, the time left to realise the savings in 2020 will have been reduced by 2 years. Some of this delay can be caught up with. But for some of the saving potential, replacing/ saving measures are only considered once in the period 2005-2020. And if this point in time was in the period 2005-2007, then the delay cannot be caught up with anymore. Therefore the savings that will be realized will be at maximum a factor 2/15 smaller than in table 4.

From this analysis it can be concluded that the saving speed of 2 %/year (Daniëls et al., 2006) can be realised in the built environment, but only at high costs and under the conditions of setting standards and providing financial support. At a national level (all sectors included) and using the broad definition of 'saving', 2.1 to 2.2 %/year can be saved if the government is able to catch up with the delay due to implementation in 2007 instead of 2005. Even if these conditions are fulfilled, this will not be enough to realise 2.7 % of energy savings per year, which are necessary to realise the 20 % of additional savings foreseen in the Green Paper on Energy Efficiency.

References

Action Plan for Energy Efficiency: Realising the Potential', COM(2006)545 final van 19-10-2006

Daniëls, B.W. and J.C.M. Farla (2006), Potentieel verkenning Klimaatdoelstellingen en energiebesparing tot 2020, Febr 2006, ECN-C—05-106

Daniëls, B.W. et al. (2006), Instrumenten voor energiebesparing, Dec 2006, ECN-E—06-057,

Daniëls, B.W., et al.(2007), Under Construction, Beleid voor Energiebesparing, ECN

Doing More With Less, Green Paper on Energy Efficiency COM (2005)265 final of 22 June 2005

Paper on Energy Efficiency (2006), Sep 2006, ECN-E--06-016

Dril, A.W.N. van, et al. (1999): Toekomst warmtekrachtkoppeling, ECN-C—99-086

Dril, A.W.N. van en H. Elzenga (2005) Referentieramingen Energie en Emissies 2005-2020, ECN/RIVM, Petten/Bilthoven, ECN-C-05-018, maart 2005

Graus, W.H.J., S. Joosen (2003), Inventarisatie Warmtepompen 1994-2002, Ecofys 2003

Harmelink, M. en K. Blok (2004), Elektriciteitsbesparing als alternatief voor de bouw van nieuwe centrales, Ecofys, 2004

Harmelink, M. et al. (2005) , Mogelijkheden voor versnelling van energiebesparing in Nederland, Ecofys 2005

Joosen, S. et al. (2004), Evaluatie van het klimaatbeleid in de gebouwde omgeving 1995-2002, Ecofys 2004

Menkveld, M. et al. (2005), Het onbenut rendabel potentieel voor energiebesparing, ECN-C-05-062 ECN 2005