INFLUENCE OF PAST POLICIES ON TODAY'S ENERGY SAVING INITIATIVES

A.G. ENTROP Eng.[1]
H.J.H. BROUWERS Prof. Dr. Eng.[1]

[1] Department of Construction Management and Engineering, University of Twente, Enschede, Overijssel, The Netherlands, a.g.entrop@utwente.nl, h.j.h.brouwers@utwente.nl

Keywords: policy, regulation, energy saving, historical research

Summary

In this paper the Dutch situation regarding national policies influencing the energy performance of dwellings is analysed by using Mahlia's theory on the hierarchy of energy policies.

The National Insulation Program is the first policy to be discussed. It was developed from 1974 to 1978 and remained in force till 1987. The objective of this program was to (re-)insulate 2.5 million dwellings to save 1.6 billion m^3 of natural gas per year. This high ambition required a broad scope affecting consumers, industries and institutions. Consumers received information on energy saving techniques and subsidies. Industries flourished, because of the increasing demand on insulation materials, and at institutions the administration of the policy and research on energy saving techniques were executed. By the end of the program annual energy savings had risen to 50 PJ.

With the proclamation of the National Energy saving Plan in 2007 a new annual objective of insulating 200,000 to 300,000 buildings was formulated for the next ten years. To achieve this goal, in a country with approximately 7 million dwellings, more information should be needed about the current physical state of buildings. However, the Energy Saving Plan does not consider yet the achievements of former policies, such as the National Insulation Program.

1. Introduction

The Dutch energy supply changed radically when at the 22nd July of 1959 the extraction of natural gas from the earth started at the small village of Slochteren. The reserve of natural gas of $2.7 \cdot 10^{12}$ m^3 was to be one of the biggest in the world. Because of this apparently endless supply of natural gas, social housing was provided with central heating systems based on natural gas already in the sixties. The use of natural gas was strongly stimulated by the government, because its price was expected to drop rapidly as soon as cheap nuclear energy would set in.

However, the price of electric energy never dropped and nowadays the existing building stock receives much attention in energy saving policies around the world. In Europe the built environment accounts for more than forty percent of the energy consumption (EC, 2002). Especially the existing building stock that was constructed before energy saving policies were commissioned, offers many opportunities to implement measures, which lower the energy consumption and which rely on renewable energy sources. Nevertheless, little is known about which policies were commissioned when and how these past policies influence the effectiveness of new energy saving regulations or objectives.

In this field Mahlia et al. (2002) aimed at developing a comprehensive theory on energy efficiency standards and labels usable for policy makers. They specified a hierarchy of test procedures, standards and labels (see Fig. 1). They claimed that their theory can be used for revisions in a country that already has standards. In this regard The Netherlands forms an interesting research field, because two standards to express the energy performance of dwellings already were introduced more than seven years ago, namely the Energy Performance Advice (SenterNovem, 2003) and the Energy Performance Coefficient (NNI, 1995). An official label was only recently, i.e. January 1st 2008, introduced and the conditions of incentive programs in adopting energy saving or renewable energy techniques were changed multiple times.

The foundation of the triangle is formed by energy test procedures, which are, according to Mahlia et al. (2002), well-defined protocols or laboratory test methods. Using these protocols or methods a relative ranking of the energy efficiency among alternative technological designs that provide an energy consuming service can be obtained. The standards form the next level of the triangle. They can define a minimum level of energy performance or maximum level of energy use. Labels are the visualization of the standards. The top of the triangle is formed by incentive programs that can influence the adoption of labels and standards among consumers, being the users of the energy consuming product, and manufacturers, being the developer and/or producer of the energy consuming product.

Using this triangular model this paper will explain the Dutch situation regarding the energy consumption in residential real estate, in which a major energy saving policy plan from the past with the name of National Insulation Program (NIP) influences the feasibility of recently set targets in the National Energy saving Plan (NEP). In the time period between the NIP and NEP, which both have an effect on existing buildings, other regulations in the national Building Code were introduced to lower the energy consumption of new buildings. Combining the results of these different governmental initiatives can provide insight in the constitution of the Dutch building stock.

Although Beerepoot et al. (2007) have already paid much attention to the energy performance regulation in the Dutch residential building sector, they did not include in their analysis the former policy that influenced the energy performance of existing residential buildings, i.e. NIP. Furthermore, the NEP forms a new policy variable to be regarded in this paper, that will describe and relate the initiatives regarding residential real estate in a chronological sequence. Firstly, the intentions and results of the NIP will be presented. Secondly, the impact of the Building Code will be discussed. And thirdly the targets and presumed effectiveness of the recently presented NEP will be related to the current residential building stock. In doing so, the number of policy independent and dependent variables of the research model of Beerepoot et al. (2007) can be chronologically extended.

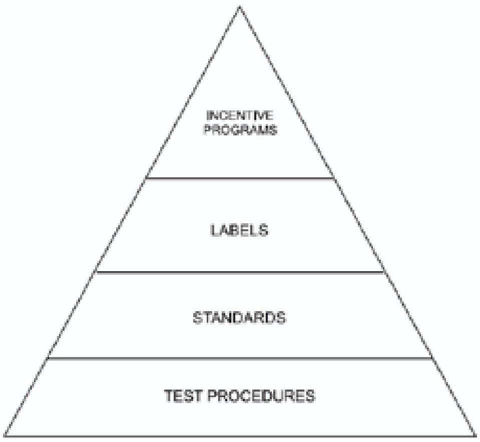

Figure 1 Hierarchy of test procedure, standards and labels according to Mahlia et al. (2002).

2. National Insulation Program (1978-1987)

In the year 1973 the first oil crisis quadrupled the Dutch oil price and therefore the costs of living were increasing tremendously. The finiteness of fossil fuels, mentioned by the Club of Rome (Meadows et al., 1972), in combination with the present increasing needs for them had its financial impact. The consensus to save energy in the built environment was growing in those early seventies, in which the first national Note on Energy was proclaimed. The global and national energy situations were discussed in this note and guidelines were set for the nearby future. There were also chapters written about the main energy sources: natural gas, oil, coal, and nuclear energy (Min. EA, 1974).

However, this political act did not provide the practical action that was needed in the built environment. An organizing committee was established, consisting of officials of different ministries and public utilities. In February 1978 they presented their program with the target to annually improve the insulation of 250,000 houses to an adequate level for the next ten years. The residential building stock counted approximately 4.6 million objects at that moment. Before presenting the program, the feasibility of this task was being tested from 1974 to 1977 by insulating 400 public housing units in the city of Enschede, 292 low-rise dwelling in the city of Apeldoorn, and 274 single-family dwellings in the city of Delfzijl (SNIP, 1988).

2.1 Scope and targets

The National Insulation Program was discussed by the Dutch cabinet. At the 30th of June 1978 it was decided that the following main items would give the program its final shape (SNIP, 1988):

1. The target of improving the insulation of 2.5 million houses in total was adopted, but the annual target of 250,000 was reduced to 200,000 dwellings. The total duration would therefore increase from 10 to 12.5 years;

2. The average subsidy on insulating techniques to be provided was stated to be € 1089,- with the possibility to increase the maximum sum of subsidy from € 1361,- to € 1815,- per dwelling[1];
3. Until 1980 the maximum amount of subsidy per dwelling could only be 30% of the investments, instead of the originally proposed $33^1/_3$%.
4. Dwellings without central heating system could also apply for the subsidy on insulating techniques;
5. Social housing corporations were enabled to invest in insulation by offering them a special type of loan in cooperation with the banks;
6. The available budget for the program was set on € 157 million for 1978 and 1979. This budget included the costs for the organisation, information and execution of the program. The national budget of 1978 showed that total governmental expenditures were € 50,145 million and total revenues were € 45,663 million (SN, 2008);
7. Furthermore, it was decided that the Association of Dutch Municipalities became member of the organizing committee.

The foreseen reduction in energy consumption was estimated to be 650 m^3 per dwelling (SNIP, 1980). At the end of the program the total target was to save annually 1.6 billion m^3 of natural gas. Using a caloric value of 31.65 MJ/m^3 to 35.17 MJ/m^3, this would mean an annual reduction of 50.6 to 56.3 PJ. In 1978 the total energy consumption of the Netherlands was 2,797 PJ (SN, 2007). The energy use of dwellings in that year was approximately 381 PJ. The NIP could reduce this by 14%.

2.2 Experience and the development of knowledge

Approximately 400,000 dwellings were already insulated in the Netherlands, before NIP was introduced (SNIP, 1988). This meant that not even ten percent of the Dutch dwellings were insulated at that time. Three quarters of these insulated dwellings were privately owned and one quarter was owned by social housing corporations. Therefore, not much experience or knowledge was available on how to insulate dwellings properly, and knowledge that was available was not centralized. In four fields research was needed (SNIP,1988):

1. The effectiveness of the use of insulation in buildings;
2. Alterations in comfort caused by the use of insulation;
3. The influence of insulation on the technical quality of the buildings (for example rotten wood caused by condensation);
4. The occurrence of physical phenomena, for example thermal bridging.

In 1979 the first publications for consumers came available regarding the effectiveness of building insulation. Because insulating a dwelling was and is a technical matter, this brochure explained the effectiveness and application of common insulation materials. The consumers were able with help of this brochure to calculate the investment costs and benefits of double glazing and insulating floor, walls, and roof (SVEN, 1979).

Although the first attempts to come to standardisation regarding the thermal insulation of dwellings originate from 1964, it would take to 1992 before national regulations were drawn up. The norm of 1964 demanded insulation values of 0.43 up to 1.29 m^2·K/W for outer walls, depending of the weight of the wall and of the aspired classification; moderate, sufficient or good. According to that norm a heat resistance of 0.17 to 0.52 m^2·K/W for floors was considered to be sufficient. The roof insulation was rated between 0.69 and 1.29 m^2·K/W (NNI, 1964). In 1981 a new standardisation was suggested incorporating the average heat transmittance coefficient of a building and a thermic insulation index (NNI, 1981).

In addition to the four fields of research mentioned, research had also been undertaken to limit the dependence of fossil fuels. The possibilities to use solar energy were explored to heat space and tap water. An early report mentions four interesting results (TPD, 1975):

- When using a solar collector with a surface of 60 m^2 and a low temperature heating system, a Dutch dwelling of approximately 400 m^3 and an average heat transmission coefficient of 0.8 W/m^2·K could be supplied of energy for 70% of its needs at that time;
- The additional investment to construct a dwelling conform Figure 2 could be financially compensated for when the parts were fabricated en mass and the price of natural gas would exceed € 0.136 /m^3;
- The use of collective heat storage systems for several dwellings could be profitable starting from € 0.182 /m^3. These systems were designed to store enough heat for a period of six months;

[1] Price levels are generally related to the year mentioned in the lines.

- The development of low temperature heating systems based on 35℃ was considered to be favourable, because the efficiency of the collectors would be maximised. Nowadays, low temperature heating systems are already quite common, but in most cases the temperature does not drop below 55℃;
- The use of solar energy to heat space seemed to be less practicable for constructions of more than four floor levels.

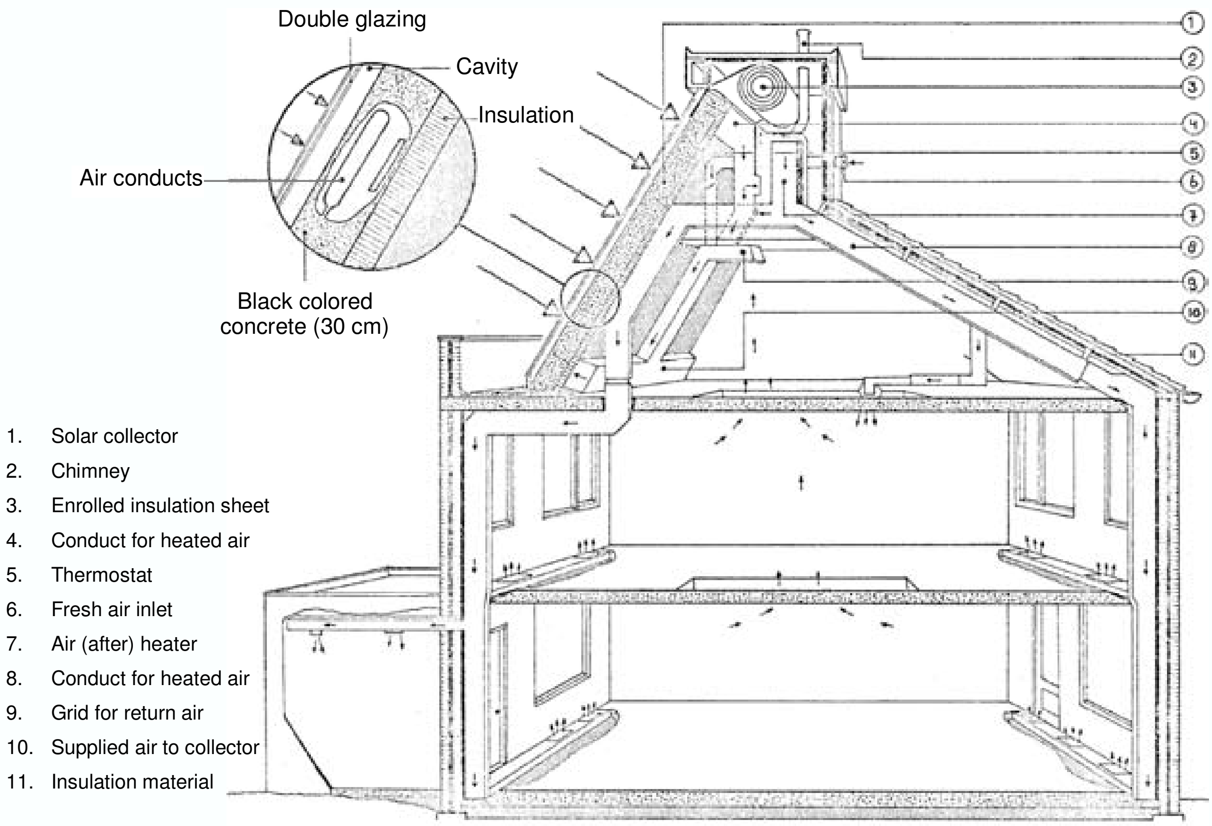

Figure 2 Design of an early solar air heated Dutch dwelling (TPD, 1975).

2.3 Financial and economic considerations

The decreasing consumption of fossil fuels should reduce the import and benefit the Dutch economy directly. The Dutch economy was also supported by generating economic activity. By producing insulation materials, installing insulation measures, conducting research, and manning the staff the employment was estimated to be stimulated by 7,500 years of labour (SNIP, 1980). A report on the evaluation of NIP even speaks of 12.500 years of labour (SNIP, 1988). The annual turnover in the new industry of re-insulation was in 1979 € 280 million, which was € 6.2 million higher than predicted (SNIP, 1980).

On micro scale the Dutch households would benefit from reduced costs on energy consumption. At least if they were willing to invest. In 1979 the average investment was € 1385 per participating dwelling. The value of the investment rose up to € 1,833 in 1987. Originally the average subsidy per dwelling was € 309 that increased to € 733 (SNIP, 1980, St. NIP, 1988). The payback period of these investments was strongly related to the natural gas price, which increased in the time period 1974-1987 from € 0.052 /m^3 to € 0.209 /m^3. In that period the highest price for natural gas was paid in 1985 with a price of € 0.300 /m^3 (SNIP, 1988).

2.4 Results

The NIP offered a broad range of stimuli to reduce the energy consumption of dwellings. The target to improve the insulation of 800,000 private dwellings and 1,700,000 rented dwellings was almost reached. The program was however brought to an end in 1987, by that time 1,803,000 subsidies with a value of € 820.9 million were approved (see Table 1). The provided subsidies formed 91 % of the total costs. At the end the annual energy consumption was reduced by 45.9 PJ to 51 PJ, depending on the use of the low (31.65 MJ/m^3) or high (35.17 MJ/m^3) caloric values of natural gas. Considering that the Dutch natural gas price nowadays is € 0.55 per m^3, then the reduction in natural gas use of $1.45 \cdot 10^9$ m^3 per year still offers consumers an annual cost reduction of almost € 800 million.

Table 1: Results of the National Insulation Program at the end of 1987

	Targets 1978-1990	Results 1978-1987	Relative Performance
Natural gas	$1.6 \cdot 10^9$ m^3	$1.45 \cdot 10^9$ m^3	90.6 %
Private houses	800,000	602,000	75.3 %
Rented houses	1,700,000	1,201,000	70.6 %

3. Building Code (1992-…) and the Energy Performance Certificate (2008-…)

The Dutch Building Code was instituted in 1992, when the buildings stock comprised 6 million dwellings. The Building Code prescribes the minimal quality a construction needs to comply with. Originally the Building Code mainly focused on the safety of constructions. Since 2001 a chapter on the environmental impact of constructions has by name been included, but this chapter has not been given any contents yet. In other words the chapter only consists of a title at this moment. The minimal thermal resistance of buildings is specified and should be at least 2.5 $m^2 \cdot K/W$. This regulation was already introduced in 1992. The total energy consumption of buildings has been regulated since 1995 by using a so called Energy Performance Coefficient (Building Code, 2003).

3.1 Minimal thermal resistance of buildings

The construction process of a new building is not allowed to start without a permit from the municipality. However, some refurbishment projects or small extensions are allowed to be constructed without a permit. In general all these projects should be subject to the minimal thermal resistance of 2.5 $m^2 \cdot K/W$. Where different construction parts are joined, a minimal heat resistance factor should also be obtained. However, often thermal bridges do occur when small extensions and bays are constructed (see Fig. 3); especially when a permit is not a necessity. In the existing building stock the connection between gable roof and walls often shows infiltration leaks.

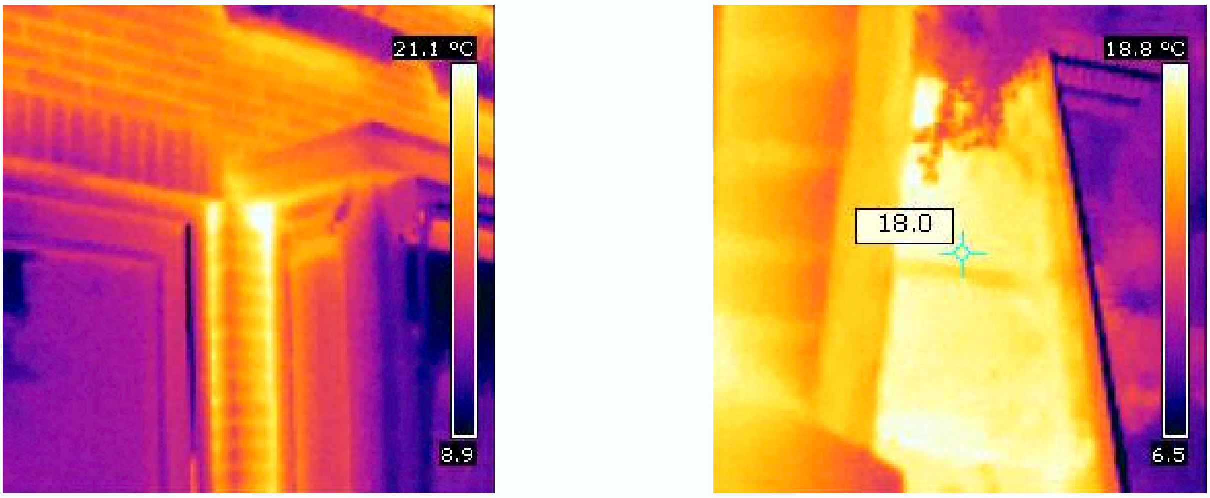

Figure 3 Pictures demonstrating the lower heat resistance of the side and roof of a bay.

3.2 Energy Performance Coefficient

Since 1995 the Energy Performance Coefficient (EPC) is being used to express the energetic quality of new buildings by relating the forecasted building related energy use to a permissible energy use based on the surface area of the object. The building's related energy use roughly includes space heating, water heating, ventilation, lighting, cooling and (renewable) generation.

During recent years the coefficient has been gradually reduced and therefore the energetic quality of new buildings has been improved. The reduced energy consumption of new dwellings resulted in a lower average on natural gas consumption of all dwellings. The average annual energy consumption per dwelling was 2,000 m^3 in 1997 and reduced to 1,736 m^3 in 2004 (SenterNovem, 2007). Nowadays, offices need to comply with a maximum EPC of 1.5 and dwellings with a maximum of 0.8 (Building Code, 2003).

Since 2008 the energy label, expressing the energy performance of houses by using letters, is compulsory in The Netherlands when dwellings are sold (see Fig 4). This label is based on the certification process of the Energy Performance Building Directive of the European Council (EC, 2002). A so called Energy Index has been developed to express the energy performance of existing and new buildings. This Energy Index leads to a specific label. The best performance is expressed by A and the worst by G. Dwellings with an EPC of 0.8 will be labelled with the status A++.

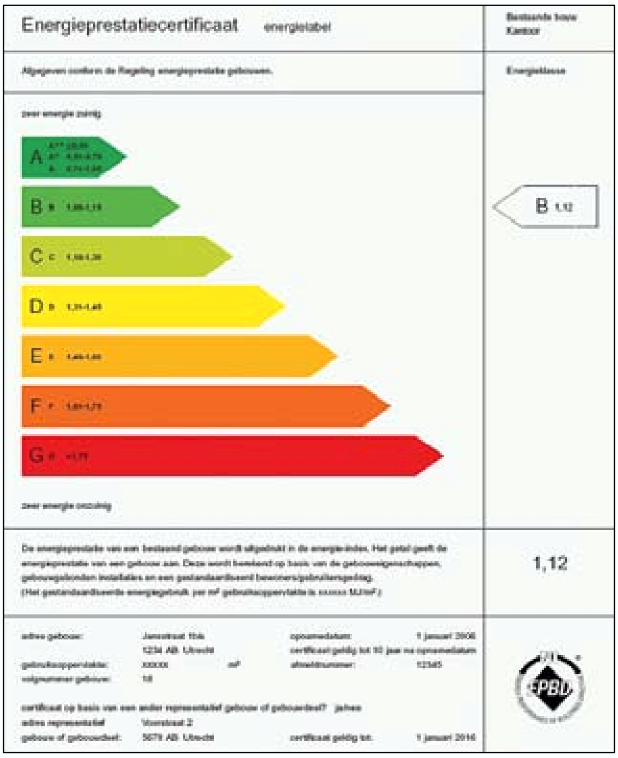

Figure 4 The energy performance of dwellings has been labelled since the 1st of January 2008.

3.3 Results

The Building Code has been stimulating the reduction of the energy consumption of buildings since 1992. In the last fifteen years around 1 million dwellings were newly constructed and were therefore provided with insulation having a heat resistance of at least 2.5 m^2·K/W. The EPC has already exerted influence on 720,000 dwellings. The Dutch government plans to have energy neutral dwellings and offices in 2020. Therefore the EPC will be further reduced to 0.6 for dwellings in 2011. In 2015 the EPC for dwellings needs to be 0.4. For offices similar reductions are planned (Min. HSPE, 2007).

Although the energy performance certificate is not addressed in the Building Code, the label can be based on the EPC, provided that the building license of the dwelling was submitted less than ten years ago. In that case the EPC has a value of 1.2 or less. In 2007 it was already possible to voluntarily obtain a label. At the 31st of December 2007 more than 50,000 dwellings had received a label. Most dwellings (23%) of this group have a D-label and only 1.75% has an A-classification or better (SenterNovem, 2008). According to Gram-Hanssen et al. (2007), the energy labels should be seen as one input, among others, to people's own knowledge and communication about their house and its renovation. Their vision is based on the Danish and Belgium experiences among homeowners regarding energy labeling.

4. National Energy saving Plan (2008-2020)

In June 2007 a proposal was prepared by EnergieNed (the Dutch Federation of Energy Companies), PeGO (the organisation for Energy Transition in the Built Environment), and Aedes (Association of Housing Corporations) to reduce the energy consumption in the built environment with 100 PJ/year in 2020. Although they gave it the name of National Energy saving Plan (NEP), it was more a proposal than a plan. In this chapter no results can therefore be included yet.

4.1 Scope and targets

The NEP proposes to annually improve the energetic performance of 200,000 to 300,000 buildings during twelve years. The investments needed for these improvements are estimated to be € 15 to 25 billion. By implementing the plan approximately 10,000 jobs are expected to be created within the construction industry. The value per dwelling is expected to increase with € 4,000 to 6,000. In 2020 the annual natural gas consumption should be reduced by 2.0 billion m^3 and the electric energy use by 3.9 billion kWh. This reduction is based on the assumption that the energy consumption without changing current policies will increase to 1140 PJ/year in 2020 (PEGO et al., 2007).

At the 23th of January 2008 the Netherlands ministries of Economic Affairs and of Housing, Spatial Planning, and the Environment adopted the National Energy saving Plan by signing an agreement to have saved 100 PJ in 2020. Till 2011 the energy performance of at least 500,000 existing buildings should be improved. Besides reducing the energy use, also the adoption of renewable energy techniques will be stimulated. In 100.000 dwellings renewable energy techniques should be applied before 2012 (Min. HSPE, 2008). However, it should also be mentioned here that renewable sources do not decrease the energy consumption. They only offer a sustainable way of fulfilling this need for energy.

4.2 Proposed approach

The suggested approach focuses on rearranging the economic market for investments in energy saving. Thresholds need to be taken away and proper policies should be adopted. Commercial organisations are asked to commit actively in reaching the objective. A new organisation by name of Energiecentraal (Energy Central) will facilitate and monitor this process.

Within NEP privately owned dwellings and offices are hold responsible for the highest energy consumption in the built environment of 310 PJ/year each. In total the energy consumption in buildings was estimated to be 950 PJ/year. Most of the savings should be accomplished among the privately owned dwellings, namely 43 PJ/year in 2020 (PEGO et al., 2007).

5. Conclusions

In this paper three important Dutch policies in reducing the energy consumption in the built environment were addressed:

1. National Insulation Program (1978-1987)
2. Building Code (1992-…) and the Energy Performance Certificate (2008-…)
3. National Energy saving Plan (2008-2020)

According to Mahlia et al. (2002) a hierarchy is manifested among energy saving policies. It seems however that the regarded policies lack elements of this hierarchy. Ad 1; The highly profitable National Insulation Program, saving up to 51 PJ and € 800 million per year, did not incorporate a label for example. Standardization developed before and during NIP still forms the basis to specify the quality of thermal insulation in social housing and therefore the permissible amount of rent. Ad 2; Since 1992 the Building Code refers to standards regarding minimum thermal insulation and energy performance, but does not refer to a label either. The EPC, specified in the Building Code, can however be used to obtain an energy performance certificate, being the compulsory Dutch energy label for buildings part of a transaction since 2008. Ad 3; The NEP forms the latest addition in reducing the energy consumption of the building stock. It tries to be an incentive program, but does not comprise research activities on the current state nor account for diversity of the building stock, does not incorporate any standards, and lacks financial resources.

However, the combination of the former two policies has resulted in a residential building stock with a large diversity regarding its adoption of energy saving measures. The annual energy consumption of dwellings was lowered on average. One out of four dwellings has been partially energetically improved by the National Insulation Program. One out of seven dwellings was built conform the Building Code and the EPC had its impact on one out of ten dwellings. Furthermore, many houses have been extended to create more living space. These extensions should also be insulated conform the Building Code. Furthermore, in the time period between NIP and NEP, there were, regarding budget and geographical considerations, some smaller incentive programs stimulating the adoption of energy saving measures. Accordingly it can be concluded that the target of NEP to improve the energy performance of 3 million houses is unfeasible, when not a proper inventory is made and no financial incentives tailored to individual cases are provided.

Acknowledgements

The authors would like to express their gratitude to the SenterNovem for providing financial support of the present research.

References

Beerepoot, M. and N. Beerepoot 2007, Government regulation as an impetus for innovation: Evidence from energy performance regulation in the Dutch residential building sector, *Energy Policy*, 35, pp. 4812-4825.

Building Code 2003, http://www.bouwbesluit-online.nl (In Dutch).

European Council 2002, Energy Performance Building Directive, Directive 2002/91/EC of the European Parliament and Council of 16 December 2002 on the energy performance of buildings.

Gram-Hanssen, K., F. Bartiaux, O.M. Jensen and M. Cantaert 2007, Do homeowners use energy labels? A comparison between Denmark and Belgium, *Energy Policy,* 35, pp. 2879-2888.

PeGO, EnergieNed and Aedes 2007, Meer met Minder; Nationaal energiebesparingplan van energieleveranciers en organisaties actief in de gebouwde omgeving (In Dutch).

Mahlia, T.M.I., H.H. Masjuki and I.A. Choudhury 2002, Theory of energy efficiency standards and labels, *Energy Conversion and Management,* 43, pp. 743-761.

Meadows, D.H., D.l. Meadows, J. Randers and W.W. Behrens 1972, The Limits to Growth, The Club of Rome, *Universe Books*, New York.

Ministry of Economic Affairs (Min. EA) 1974, Energienota (In Dutch), Tweede Kamer, zitting 1974-1975, 13 122 no 1-2.

Ministry of Housing, Spatial Planning and the Environment (Min. HSPE) 2007, Afspraken over klimaatdoel-stellingen kabinet op koers (In Dutch), http://www.vrom.nl/pagina.html?id=31880, 14-06-2007.

Netherlands Normalisation Institute (NNI) 1964, NEN 1068 Thermische eigenschappen van woningen (In Dutch), UDC:697.1:699.86.

Netherlands Normalisation Institute (NNI) 1981, NEN 1068 Thermische isolatie van gebouwen; terminologie en rekenmethoden voor stationaire situaties (In Dutch), UDC 699.86:001.4.

Netherlands Normalisation Institute (NNI) 1995, NEN 5128 Energy performance of residential functions and residential buildings – Determination method (In Dutch), ICS 91.120.10.

SenterNovem 2003, Handleiding basismethode EPA software (In Dutch) version 4.02.

SenterNovem 2007, Cijfers en tabellen 2007 (In Dutch), 2KPGE-07.05, in order of the Netherlands Ministry of Housing, Spatial Planning and the Environment, Sittard.

SenterNovem 2008, Monitoring EPBD until 31st of December 2007.

Stafbureau Nationaal Isolatie Programma (St. NIP) 1988, Rapportage over het jaar 1987 inzake het Nationaal Isolatie Programma (In Dutch).

Statistics Netherlands (SN) June 2007, Statline database; Veranderingen in de woningvoorraad en Energiebalans (In Dutch), http://www.cbs.nl, Voorburg/Heerlen.

Statistics Netherlands (SN) March 2008, Statline database; Historie overheid rijksfinanciën (In Dutch), http://www.cbs.nl, Voorburg/Heerlen.

Stichting Voorlichting Energiebesparing Nederland (SVEN) 1979, Isolatie-wegwijzer; voor energiebesparing in woningen (In Dutch), second edition, Apeldoorn.

Stuurgroep Nationaal Isolatie Programma (SNIP) 1980, Rapportage over het tweede halfjaar 1979 inzake het Nationaal Isolatie Programma van de stuurgroep NIP aan de bewindslieden van VRO en EZ (In Dutch), Rotterdam.

Stuurgroep Nationaal Isolatie Programma (SNIP) 1988, Evaluatie 10 jaar Nationaal Isolatie Programma 1978-1988 (In Dutch).

Technisch Physische Dienst (TPD) TNO-TH 1975, De mogelijkheden in Nederland voor het gebruik van zonne-energie voor ruimteverwarming en warmwatervooziening (In Dutch), written by eng. C. den Ouden, Delft.