Lessons on the proportionality of the implementation of the EPBD directive 2010

A study on the implementation in the Netherlands

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Main conclusions

The Dutch Advisory Board on Regulatory Burden ('Adviescollege Toetsing Regeldruk' (ATR)) has commissioned the Economic Institute for Construction and Housing (Economisch Instituut voor de Bouw (EIB)) to research the implementation of the European Energy Performance of Buildings Directive (EPBD) of 2010 into national legislation in the Netherlands and five other European countries (Denmark, England, Germany, Norway, Portugal). The objective of the EPBD is to reduce energy consumption and the emissions of greenhouse gasses by 20% compared to 1990 levels and to produce 20% renewable energy in 2020[1]. The aim of the study is to give recommendations on the design of national legislation concerning the energy performance of buildings, given the effects on regulatory burden and associated benefits and its proportionality. Furthermore, insights into the proportionality of the implemented measures will be provided by evaluating the additional regulatory burden relative to the associated (social) benefits. Finally, recommendations are presented based on the implementation of the EPBD in other countries.

Regulatory burden has explicitly been considered during the implementation of the system of EPCs and system inspections in the Netherlands

In general, regulatory burden has been considered during the implementation process of the directive in national legislation in the Netherlands concerning EPCs (energy labels) and system inspections. The system of energy performance certificates was designed to assure easy compliance, mainly for private home owners, and to limit the regulatory burden. In 2015, a 'simplified energy label' was introduced together with a control system, as the existing system with on-site visits was deemed undesirable due to higher costs. The implementation of simplified labels in 2015 reduced the expected yearly costs by approximately € 14 million based on transaction data from 2013[2].

Aside from the Netherlands, Norway[3] has also adopted a simplified EPC (energy label) for privately owned residential buildings. Just like in the Netherlands, the implementation of simplified labels was chosen to limit the regulatory burden of obtaining an energy label for home owners. In both countries, the simplified label is obtained by providing information on houses through an online platform. In the Netherlands an expert signs off the information and has the option to ask additional questions and proof, while in Norway no expert is involved in the process. In Denmark, an EPC that does not require an on-site visit is available for single-family homes that are built within the past 25 years if they have not been changed since. The other researched countries (Portugal, Germany and England) have opted for expert-EPCs, which require an on-site visit. These EPCs have to be obtained at a cost that is significantly higher than that of the simplified label. The costs range from free to about € 150 for simplified EPCs[4] compared to € 250 to € 850 for expert EPCs. Table 1 gives an overview of the different types of EPCs for residential buildings in the researched countries.

As of 2002 the directive prescribes a regular inspection of boilers and air-conditioning systems of a certain size. The Netherlands have limited regulatory burden as a consequence of this directive by showing how, with existing practices for boilers, the requirements are met in an alternative way. Furthermore, as energy savings attributable to inspections were deemed limited, it has been chosen to not actively control whether inspections take place. As a consequence, regulatory burden is limited in practice.

[1] These objectives are not tied to objectives at the level of member states.

[2] SIRA Consulting (2014), Regeldrukeffecten vernieuwd energielabel voor woningen. As transactions in 2013 were at a very low point and numbers of transactions increased the following years, the reduction in costs has been higher in practice.

[3] Norway is a non-EU-member and therefore is not obligated to comply to the EPBD.

[4] Denmark's simplified EPC has a cost of € 150, while its expert EPCs are issued at a fee of € 500 - € 700. In Norway the simplified label can be obtained for free and in the Netherlands the cost is about € 10.

Table 1 Implementation of EPC requirement for residential buildings in the different countries

Denmark	England	Germany	Netherlands	Norway	Portugal
– Simplified EPC without on-site visit (single family houses <25 years old) – EPC based on measured energy consumption (multi-family rental properties) – Expert EPC	– Expert EPC – Apartment buildings: only one unit has to be visited on-site if representa-tiveness can be proven	– Expert EPC – EPC based on measured energy consumption (only allowed for particular buildings)	– Simplified energy label (privately owned houses) – Expert EPC (social housing)	– Free of charge online EPC assessment (simple or detailed registration) – Expert EPC (voluntary)	Expert EPC

Source: EIB

Added value of EPCs is limited in practice

In order to assess the proportionality of the Dutch implementation of the EPCs, the benefits of the EPCs have to be established. Different studies have been conducted to assess the effectiveness of energy labels in the Netherlands. Some studies conclude an influence of EPCs on prices[5] (not attributable to energy savings) and an influence on time to the market[6]. In order to assess the value of these studies, it has to be established whether these influences are the sole result of the energy label or that other factors are responsible for these premiums, so called composition effects. Based on the methodology, composition effects cannot be ruled out in these studies. CPB[7] has recently analyzed available literature and a possible price premium. The institute concludes that 'a better label does not associate with a price premium at the margin (between energy labels). While energy efficiency is well-capitalized, energy labels do not seem to provide additional information that is not already priced in the market'. A number of other studies confirm that there is no evidence that a better energy rating results in a price premium that is *not* related to the energy savings of better EPCs [8] [9] [10]. This lack of an additional price premium is confirmed by our expert interviews.

Another possibility is that EPCs lead to a higher awareness and as such contain triggers to invest in energy saving measures. There is no irrefutable evidence that supports this effect, but

[5] Brounen, D., Kok, N. (2011), On the economics of energy labels in the housing market, Journal of Environmental Economics and Management.

[6] Aydin, E., Correa, S.B., Brounen, D. (2019), Energy performance certification and time on the market, Journal of Environmental Economics and Management.

[7] CPB (2020), The information value of energy labels: Evidence from the Dutch residential housing market.

[8] Jessica Havlínová en Dorinth van Dijk (2019), Verplichte energielabels hebben positief effect op verduurzaming van huizen. ESB, 12 september, 2019, https://esb.nu/esb/20055699/verplichte-energielabels-hebben-positief-effect-op-verduurzaming-van-huizen.

[9] Olaussen, Oust and Solstad (2017), Energy Performance Certificates – Informing the Informed or the indifferent?, Energy Policy, vol 111, p.246-254.

[10] PBL (2020), Woonlastenneutraal koopwoningen verduurzamen. The study mentions 'different studies on the effect of energy labels on value, show a fairly consistent result of limited value effects.'

two studies based on surveys suggest that EPCs can play a small role in taking energy saving measures. One study mentions a weak influence on purchase decisions[11], and another study based on surveys[12] states that 'the energy label has a positive effect on awareness' and mentions that '10% of the people who took energy saving measures would not have done this without the energy label'. On the other hand, the same study brings forward that 'only few people state that the energy label is the reason for taking energy saving measures and that financial consequences play a much more important role'. Based on these studies, a certain positive effect of EPCs on awareness and energy saving measures cannot be ruled out.

In the conducted interviews, other main reasons are given for investments in energy saving: comfort and financial triggers are named as the primary incentives. In order to increase the effects of the EPCs on energy savings, multiple countries are evaluating the design of the EPC as the current designs do not lead to satisfactory results[13]. The importance of financial triggers is confirmed in the aforementioned study by Kantar. Some financial institutions use EPCs to determine maximum mortgages and to give discounts on interest rates for better EPCs. If these favorable conditions have an effect, they lead to a higher demand for buildings with better EPCs. The prices of these properties rise and a price premium is observable. As shown, this price premium is not present as yet, although some effect of favorable conditions cannot be excluded in the future, dependent on the design. As financial triggers are the primary reason for investing in energy saving and as better EPCs currently yield no price premium, the effect of energy labels on behavior seems limited in practice. From this point of view, the choice for simplified energy labels for residential buildings seems balanced.

Increase of costs due to reintroduction of expert EPCs

The EPBD III of 2018 prescribes that the energy rating of buildings must be based on the primary energy demand and expressed in kWh/m^2 per year for transparency and uniformity across member states. In order to do this, a new software package, the NTA 8800, has been developed in the Netherlands. This package depends more strongly on the geometry of the building. As private home owners were found to have too many problems providing the correct information themselves, simplified labels will be abandoned from 2021 and the EPC can only be issued by an expert based on an on-site visit from this date. This will lead to an increase in costs for home owners. On a yearly basis, a system of expert EPCs would increase costs for private and commercial home owners by approximately € 33 million as compared to a system of simplified labels[14]. If every privately and commercially owned home (approximately 4.8 million dwellings) would need to obtain an expert energy label[15] at an additional cost of € 150 per home compared to simplified labels, this would mean an additional cost of € 720 million.

Given this cost increase it is relevant to determine whether people are truly unable to provide accurate information on the geometry of their building. This inability is concluded in a study that observed the behavior of eight respondents in providing information for a simplified label, which can hardly be seen as representative[16]. Besides this, people do not necessarily need to measure their home themselves: most documentation that is handed over when buying a house contains a floor plan. If people do not have the documentation anymore, a call to the estate agent could be enough to obtain one. Finally, the role of the expert is underestimated in

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[11] Evaluation of Directive 2010/31/EU on the energy performance of buildings, Commission Staff working document, 30 November 2016, SWD(2016) 408 final. This report refers to a study based on the Dutch situation (Murphy, L. (2014), The influence of the Energy Performance Certificate: the Dutch case.).

[12] Kantar (2017), Onderzoek effect energielabel voor woningen.

[13] Portugal and Germany, for instance, are discussing including comfort in the EPC system, as the current design does not incentivize people enough to take energy saving measures. The belief is that by stressing the increase in comfort, for instance when applying insulation, more measures will be taken than when the focus lies on energy (saving).

[14] In conducted studies in 2019, the additional yearly regulatory burden for homeowners was estimated at € 19.5 million, however this was based on too low a level of yearly transactions. The original calculation can be found in: SIRA Consulting (2019), Lastenmeting wijziging energieprestatiemethode en inijking energielabels. This difference stresses the importance of accurate cost/benefit analysis before decision making, as brought forward later in these conclusions.

[15] The social housing stock uses on-site expert EPCs as the maximum rent is partly based on expert EPCs.

[16] RVO (2019), Vereenvoudigd Energielabel NTA 8800. Overkoepelende rapportage uitgevoerde onderzoeken haalbaarheid Vereenvoudigd Energielabel (VEL) methodiek o.b.v. NTA 8800.

the conclusions of the study. In the current situation, an expert signs off the information that is provided by the home owner and one can assume this situation can be kept in place. The expert will check the information, asks follow-up questions and gives advice on how to deliver proof of insulation or glazing, for instance. Furthermore, the expert could check the dimensions of the building in public databases like the BAG[17]. In the conducted study, it is stated that 'questions that are initially unknown or complex to people, become recognizable with the help from a professional advisor and can be answered and proven with this help'. These findings indicate that it seems possible for people to provide the correct information and, with experts remotely signing off the information, mistakes can be minimized. The fact that Norway has a well-functioning simplified label that is also based on kWh/m^2 per year and where geometry is also part of the provided information, supports this finding.

The second question that needs to be answered is: what are the consequences if inaccurate information on the geometry of the building is provided and signed off by an 'online expert' for a small number of cases? According to DGMR[18], inaccurate measurements of 10% to 20% of the floor surface can lead to deviations of 7% to 15% in energy use. Of these inaccurately measured homes, about 30% to 40% would be allocated to the 'wrong' energy class. These wrongly assigned dwellings will generally deviate one energy class from to the 'right' measurement. In the old system, based on the Energy Index, about 93% of the dwellings would be rightly assigned despite the aberration. As a result, a simplified label based on the NTA 8800 was deemed too inaccurate compared to the current system and expert EPCs were reinstated[19].

From expert interviews, it can be concluded that the experiences with the simplified EPCs in the different countries are generally positive. The general belief is that they provide relatively good and objective information about the energy performance of houses at significantly lower costs. Experts do indicate that the simplified label may be less accurate than EPCs for which an on-site visit is needed. However, in interviews it has been stressed that the energy rating may also turn out different when on-site visits are used, as experts assess situations differently.

The analysis above leads to the question whether reinstating expert EPCs is desirable. The significant increase in costs has to be compared to the value and benefits of the EPC. As noted, a certain positive effect of EPCs on energy saving investments cannot be ruled out based on conducted studies. However, there is no reason to assume that these effects are significantly larger when using an expert EPC compared to using an online EPC. The international comparison shows that an online label can be implemented using kWh per square meter per year as a metric, as Norway has been using such a system. Currently, there are no policies in effect that use the EPC as a basis[20], which means that a (possible) lack of accuracy does not have large consequences. Furthermore, expert EPCs are not fully accurate either. Considering the above and the significant cost increase, EIB concludes that the use of simplified energy labels could well be the appropriate design.

If there are concerns about the accuracy of simplified labels, further research can be worthwhile. By taking samples of issued simplified labels and having the same homes visited by, for instance, three experts, the (possibly) different outcomes in practice can be measured. The extent to which the results differ can be analyzed and, based on the differences, the quality of online labels can be improved and the desirability of a possibly more accurate expert EPC can be determined. In determining the desirability for expert EPCs, the fact that an expert EPC can be ten to twenty times as expensive for home owners compared to simplified EPCs should be taken into account as well as the fact that benefits should be proportionate.

[17] Basisregistraties Adressen en Gebouwen, which contains total square meters of a building, for instance.

[18] DGMR (2019), Vereenvoudigd Energielabel NTA 8800.

[19] The study of DGMR shows more effects of aberrations, but these are significantly smaller than the one mentioned here. It is important to note that DGMR researched if a simplified label could be based on the NTA8800 with at least the same accuracy as the current simplified label. The answer to this was negative, resulting in the decision to reinstate expert EPCs.

[20] The 'woningwaarderingsstelsel' and RVV uses EPCs, but only expert EPCs are used to this effect.

Possibility to use EPCs as a means for energy saving policies can be examined

Currently, EPCs are not used in policies to increase energy saving, while expenses have been made to introduce the system. In regard to energy saving, EPCs could play a role as a policy instrument. The reasoning for using EPCs as a means for policy making is twofold. Firstly, EPCs (or an equivalent) are compulsory by European law and as a consequence a system of measuring and tracking EPCs in the Netherlands is in place and will probably be used for a longer period of time. When policies are designed efficiently, using a firmly established system will likely lead to less regulatory burden and costs than creating a new system as a basis for energy saving policy. Secondly, both simplified and expert EPCs give a relatively good indication of the energy performance of the building, providing a sound basis for policy making.

England and the Netherlands have introduced minimum standards based on EPCs in the non-residential sector, subsidy schemes based on EPCs were active in the Netherlands and Portugal and tax benefits for better EPCs haven been given in England and Portugal by local authorities in the past. These examples show that EPCs can be used for policies that stimulate energy saving measures. If this is considered, a reliable and accurate EPC becomes more important. In this case, it is advisable to further research the implications of keeping simplified labels under the new system, for instance using the method described in the previous paragraph.

Currently, there is no reason to assume that home owners deliberately file wrongful information regarding their home. If there are worries over fraud when using simplified labels in combination with, for instance, subsidy schemes, an efficient quality control system needs to be in place. Samples can be taken and high sanctions can be enforced. High sanctions have a deterrent effect and improve compliance without leading to a large increase in regulatory burden for governments. In order to reduce disputes over assigned labels and to limit the negative effects of inaccurate measurements by home owners when simplified labels are used, a less detailed system may be appropriate. Decreasing the number of categories (for instance from A-G to excellent-good-average-below average) may be beneficial in this case.

In addition, the introduction of simplified labels for social housing could be considered. Currently, because of the 'woningwaarderingsstelsel' owners of social housing have an incentive to obtain expert EPCs for their property as these play a role in the determination of the maximum rent for these houses. Since expert EPCs are about eight times more costly than simplified labels for social housing corporations and since experiences with simplified labels are generally positive, introducing simplified labels for social housing corporations could be a proportionate measure. This does depend, however, on the interference with other existing rules and regulations and accuracy of the label. Regulatory burden and benefits that occur due to adjustments of existing rules have to be considered.

Path to NZEB-buildings increased regulatory burden

The EPBD of 2010 requires Member States to set a definition for Nearly Zero Energy Buildings (NZEB) as a minimum requirement for new buildings by 2020. The EPBD provides member states the possibility to define NZEB with a large degree of discretion as no standards are prescribed. Furthermore, NZEB requirements do not have to be set more stringent than cost optimal levels: if cost optimality cannot be maintained, tightening of minimal requirements is not required. The use of kWh/m^2 per year as an indicator, on the other hand, is mandatory.

In the build up towards 2020, intermediate requirements were set in all researched countries. As such, the minimum requirements have developed in a similar way across nations. While tightening the minimum requirements, all countries have performed cost optimality assessments. Germany, England and Denmark have implemented cost optimal minimum requirements in process to 2020, while the Netherlands and Portugal did not maintain full cost optimality[21]. In the Netherlands, the tightening of minimum requirements from EPC 0.6 to 0.4 in

[21] In Denmark, the 2010 minimum requirements were not cost optimal, as industries did not have enough time to prepare for the new standards. This was corrected in the 2015 minimum requirement which ensured cost optimality. In 2020 however, cost optimality could not be maintained due to lower energy prices and lower taxes.

2015 was more stringent than cost-optimal. The additional average initial investments for residential buildings were estimated to rise by about € 8,500[22]. Between 2015 and 2019 approximately 60,000 buildings a year were subject to these more stringent requirements. This adds up to total costs of about € 500 million each year. The findings of the cost optimality studies show that between one- and two-thirds of the initial investments will not be earned back[23] [24] based on theoretical energy savings and life cycle costs. In England and Germany, where requirements are set at cost-optimal levels, the higher costs are earned back by a reduction of the energy bill. The annual CO_2 reduction as a result of the tightening amounts to 43,000 tons for 60,000 newly built houses each year. This entails about 0.2% of the total CO_2 emission of the built environment in 2015.

Additional investments related to NZEB standards will not be earned back

With the implementation of NZEB, the ambition to reduce energy further is embedded. In this regard it is worthwhile to assess what a further tightening of the EPC would mean. A hypothetical tightening from EPC 0.4 to 0.2 would cause the cost of a new residential building to rise by € 15.000 on average according to construction firms. This rise in costs is twice as large as the increase of costs of the earlier threshold adjustment from 0.6 to 0.4. Of these additional costs, about 75% will not be earned back. This example shows that a further tightening would be cost inefficient.

Due to the obligation to express NZEB buildings in kWh/m² per year, the Netherlands had to let go of the EPC standard and new calculation methods, based on the NTA 8800, were introduced. Furthermore, in 2018 the 'wet VET' was introduced in the Netherlands. This law follows from 'De Energieagenda'[25] and states that changes in regulations are necessary to 'support the energy transition'[26]. The 'wet VET' is formally not linked to the EPBD and states that natural gas boilers cannot be part of new buildings as of July 2018. The introduction of the 'wet VET' and the system change from Energy Performance Coefficient (EPC) to kWh/m² per year as an indicator complicate the comparison of new and old standards, as indicators and calculation methods differ.

In 2019 the cost optimality study was conducted by DGMR[27], which considered cost optimality given the requirement that natural gas could no longer be applied as an energy source. Furthermore, new calculation methods based on NTA 8800 were used with kWh/m² per year as indicators. As a result of the cost optimality studies, the requirements were set at 30 kWh/m² per year in primary energy demand for single family houses and 50 kWh/m² per year for multi-family buildings, which was deemed cost optimal when eliminating natural gas as an option.

The cost optimality study shows that as a result of both NZEB standards and 'wet VET', life cycle costs increase by about € 22,500, of which about half (€ 11,750) will not be earned back[28] [29]compared to current building standards. DGMR and RVO conclude that 5% to 35% of the rise of net life cycle costs is solely attributable to the EPBD[30], equivalent to € 590 to € 4,100 per dwelling. Again, based on 60,000 newly built houses per year, this adds up to € 35,5 million to € 247 million each year, additional to the costs of the tightening of the EPC in 2015. The annual

[22] Weighted average of the additional investment costs of the EPC 0.6 to 0.4 adjustment as calculated by W/E adviseurs and Arcadis. Life cycle investment costs will presumably be higher, but no information on reinvestment and maintenance costs is available from the studies.

[23] W/E adviseurs en Arcadis (2013), 'Aanscherpingsstudie EPC woningbouw en utiliteitsbouw 2015'

[24] In the calculations theoretical energy savings have been calculated. There are indications that these earnings are lower in practice, see Majcen (2016).

[25] Ministerie van Economische Zaken (2016). Energieagenda: Naar een CO_2-arme energievoorziening'.

[26] Wet van 9 april 2018 tot wijziging van de Elektriciteitswet 1998 en van de Gaswet (voorgang energietransitie), Stb. 2018, 109.

[27] Kostenoptimaliteitsstudie NTA8800 Woningbouw en Utiliteitsbouw. DGMR Bouw (2019).

[28] Life cycle costs are initial investments, re-investments and maintenance costs.

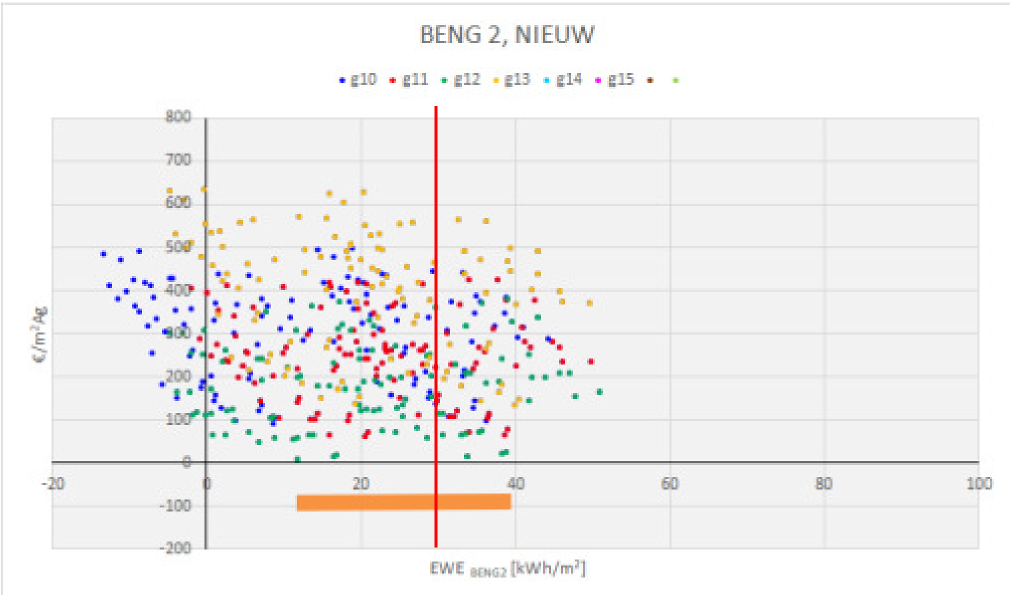
[29] Kostenoptimaliteitsstudie NTA8800 Woningbouw en Utiliteitsbouw. DGMR Bouw (2019). Weighted average of the additional initial investment costs, reinvestments and maintenance costs and benefits (energy savings and residual value) of the 20 investment packages with the lowest net present lifecycle costs.

[30] SIRA Consulting (2019) 'Effectmeting wijziging Bouwbesluit 2012'.

CO_2 reduction as a result of the minimum requirements for NZEB and the wet VET is comparable to the reduction that was achieved through the tightening of EPC 0.6 to EPC 0.4 and amounts to 44,000 tons for 60,000 newly built houses each year. The costs per saved ton of CO_2 as a consequence of both the ‘wet VET’ and NZEB standards amount to about € 1,000, which is high compared to other measures[31].

The calculation based on the cost optimality study shows that the step from an EPC of 0.4 in 2015 to 30 or 50 kWh/m² per year is not cost optimal and that that the ‘wet VET’ is for a large part responsible for the rise in net life cycle costs. Figure 1 presents the results of the calculations of reference buildings as made in the cost optimality assessment for new dwellings (excluding apartments)[32]. Each colored dot represents a different building type on which energy saving measures are projected. These energy saving measures result in a primary energy use (x-axis) and corresponding additional net costs per square meter (y-axis). Moving to the left along x-axis of the figure means more stringent requirements. As the ‘wet VET’ is in effect, solutions using gas boilers are not depicted in the figure. The current standard is set at 30 kWh/m² per year.

Figure 1 **Additional net life cycle costs and energy use in kWh/m² per year for different reference houses**



Source: RVO

From the figure, it can be concluded that there is no cost optimal point. This conclusion is also drawn by RVO in the report. The figure raises a number of questions. Firstly, in earlier researches, a relationship was established between costs and energy use: lower energy use is accompanied by (exponentially) increasing costs, as was concluded with the tightening of the EPC from 0.6 to 0.4 and the (hypothetical) tightening of EPC 0.4 to 0.2. This relationship seems apparent: lowering energy use of an already very energy efficient home is more costly than lowering energy use of an energy inefficient home[33]. This relationship between costs and

[31] ECN & PBL (2016). Kostenefficiëntie van beleidsmaatregelen ter vermindering van broeikasemissies.

[32] RVO (2019). Advies BENG eisen woningbouw.

[33] In economics, this is known as the law of diminishing returns.

energy use appears absent in the figure shown, which is notable. Secondly, the use of different sets of measures and various types of buildings explains the broad and indecisive outcomes depicted in figure 1 and makes comparison difficult. Given this situation, it is complicated to attribute costs and benefits to either the 'wet VET' or the EPBD. In this light, the attribution to the EPBD of 5% to 35% of the rise of net costs raises questions. Finally, the data suggest that a differentiation of requirements for different types of houses may be more cost efficient than setting standards for all houses on one hand and all apartments on the other.

The additional benefits of NZEB buildings compared to EPC 0.4 buildings are limited, both when benefits are calculated financial-economically and social-economically. As additional energy and CO_2 savings from NZEB buildings are small and financial benefits are related to energy savings, results of the economic and social calculations are very similar and net present values are almost identical. Therefore, also from a social-economic perspective it can be reasoned that tightening of minimum performance standards is not a cost-efficient way to further reduce energy consumption.

When NZEB standards were defined, Portugal defined NZEB beyond financially cost optimal levels and in the Netherlands NZEB and 'wet VET' are not cost optimal in combination. In contrast, England, Denmark and Germany have maintained the minimum requirements at cost optimal levels for the foreseeable future[34]. The different definitions of NZEB, the choices made in the researched countries and the related (absence of) cost optimality are a direct effect of the discretionary room member states have applied and of national decision making regarding related laws and regulations. The implementations in England, Denmark and Germany have led to less regulatory burden by maintaining cost optimal levels.

The cost optimality of the 'wet VET' itself has not been a subject of research. Considering the significant increase of the costs of new buildings, probably attributable to the 'wet VET', this is surprising. Furthermore, there are still many investment opportunities in the existing building stock that reduce energy consumption more efficiently. In conclusion, it is recommended that cost benefit analysis is considered standard procedure in regard to energy saving standards in the future. This does not exclude the possibility to consider requirements that are more stringent than cost-efficient levels if so desired, but it does make the impact of measures on regulatory burden more transparent.

From interviews it is gathered that the decision making process that led to the Dutch definition of NZEB and to tightening to Energy Performance Coefficient (EPC) 0.4 in 2015, was fairly non-transparent. Cost optimality studies of the tightening of the EPC that show that the chosen requirements were not cost optimal, were known at the time. From expert interviews it can be concluded that stakeholder committees were installed, but that their influence was limited as the desire to be more stringent in standards was very apparent. More transparency in the decision making process could lead to a better understanding of the decisions made and increase support for chosen policies.

Regulatory burden generally underestimated in ex ante studies

In ex ante studies, calculations are made to estimate regulatory burden of policy changes. In this study, an attempt is made to compare estimated and actual regulatory burden. This comparison is often difficult to make, as integrality is often missing, certain costs are not taken into account in original studies and in practice it is proven difficult to assign costs to a single rule or regulation. For the different requirements discussed in this study, table 2 compares expected and actual regulatory burden where this was possible, where initial costs represent one-off costs and structural costs occur yearly[35].

[34] Norway, as a non-EU member state, has not defined NZEB levels yet as it aims to learn from the experience of other countries first. In Denmark requirements were set in 2015 at cost-optimal levels. As a consequence of lower energy prices and taxes, however, cost-optimality has been lost in recent years.

[35] See the following chapters for a complete description of initial and structural costs. The display of the label had been marked as initial costs. For consistency reasons we have kept these costs as initial. However, these costs reoccur every 10 years or whenever a new label is received and displayed.

Table 2 Overview of expected and actual regulatory burden

Requirement	Frequency	Expected regulatory burden	Actual regulatory burden[1]
Energy performance certificates	Initial	€ 21,000,000	€ 21,000,000
	Structural	€ 11,000,000	€ 17,000,000
Minimum energy performance requirements[2]	Initial	€ 3,000,000	€ 40,000,000
Inspection of technical building systems	Initial	NA	€ 1,700,000
	Structural	NA	€ 34,000,000

1 The actual regulatory burden are the costs in case of full compliance. Regarding the system of energy performance certificates and minimum energy performance requirements these costs are close to actual practice. However, regarding the inspection of technical building systems, the regulatory burden is lower in practice as a consequence of the absence of an effective control system.
2 Excluding compliance costs

Source: EIB

For the EPCs, initial and expected regulatory burden are comparable, however, the costs for knowledge development are slightly lower, while the display of the label in buildings turned out higher in practice. Structural costs turned out higher in practice, mainly due to a higher amount of transactions requiring an EPC. For private home owners, ex ante costs were based on an estimate of 67,000 houses being sold in 2013. In practice, however, the amount of transactions has been a lot higher than in 2013 as in that year the amount of transactions was at the lowest point in the past 25 years. Our calculations are based on approximately 130,000 transactions for private home owners of existing houses a year, approximately the average over the past 10-20 years[36]. Low numbers of transactions were also applied for commercial home owners and developing companies.

The minimum requirements have been much more costly in practice. Regarding the adjustments to the minimum requirements in 2010 and 2015, ex ante studies estimated half an hour for familiarization for construction companies, leading to costs of approximately € 3 million for the two adjustments. From interviews, it can be concluded that familiarization takes about one day per construction company per adjustment, leading to a much higher regulatory burden. For inspections of technical building systems, no studies were conducted to calculate regulatory burden before it was implemented.

The researched studies on regulatory burden only present the costs of the different policy options without showing potential benefits from the systems. This may lead to suboptimal policy making when there are more costly policy options that have larger benefits[37]. In that case the least costly system may be implemented, while from the perspective of proportionality of costs and benefits another system may be preferred. Furthermore, uniformity in studies is desirable for comparison. For instance, the 2013 cost optimality studies presents initial

[36] In the calculations we assume that all transactions needed an EPC, as only very few EPCs were registered up to 2015.

[37] Appendix A proposes a method on the quantitative calculation of the proportionality of measures.

investments separately but does not specify life cycle costs, while the 2018 study does use life cycle costs. Using life cycle costs and benefits and presenting them separately, increases transparency for decision making. Finally, the accuracy of the analyses is a point of attention: by consistently using transaction data from 2013, yearly regulatory burden of a simplified energy label have been underestimated in 2015 and the costs of reintroducing expert energy labels as a result of the NTA 8800 have been underestimated by about 40% in 2019.

Room for discretion can be actively pursued

The system of simplified EPCs that the Netherlands and Denmark have used to date to meet the requirements of the EPBD are examples of actively pursuing discretionary room. Such a system is not proposed by the EPBD, but is a way in which countries have actively looked for alternatives at the implementation of the Directive into national legislation and have thereby limited regulatory burden. The European Commission provides member states the opportunity to implement alternative systems that meet the requirements as long as equivalence of the system can be proven.

There are more examples of countries implementing the directive differently than prescribed. For example, in contradiction to the EPBD guidelines, there is no minimum energy requirement for elements in case of major renovations in Denmark as this leads to lower investments. With success, Denmark argued that home owners would not renovate at all because of these requirements. This implies that whenever it can be reasoned that alternative measures to the EPBD result in a (larger) reduction of energy consumption and/or lower regulatory costs, countries have the ability to present a substantiated claim to the European Commission to deviate from the EPBD.

Another example of deviating from the EPBD to limit regulatory burden, concerns the inspection of technical building systems: none of the countries involved in this study have directly implemented the Directive regarding inspections of heating systems. Countries argued successfully that existing or alternative national directives were more efficient than the EPBD requirements and were thereby able to limit regulatory burden.

England and Portugal have implemented the directive in such a way that it limits regulatory burden for non-residential buildings. In England, non-residential building owners are not required to implement the recommendations in the EPC within its validity period. This measure minimizes extra costs as extra renovations do not have to be performed within the validity period and planned renovations are not accelerated to meet the requirement. In Portugal the requirement to display the EPC in public buildings is only required for buildings larger than 500 m^2 instead of the prescribed 250 m^2. These regulations seem to indicate that discretionary room is present.

In practice, the European Commission has granted countries more discretionary room than initially indicated. This endorses countries to critically look at the European Directive and to actively create ways to implement them cost efficiently and within existing frameworks where possible. In the Netherlands, for instance, the prescribed validity period of 10 years for EPCs leads to additional regulatory burden, as new EPCs have to be issued while no changes have been made to the building. Regulatory burden could be limited by only requiring a new EPC when changes have been made to the building that influence the energy performance. To this end, the Netherlands could discuss a list of potential renovations with the European commission on changes that require a new EPC. Also, the requirement for public authorities to implement the cost-efficient recommendations in the certificate within its validity period does not always coincide with natural renovation cycles (about every 30 years). As a consequence, additional renovations need to be done, or planned renovations have to be accelerated, which increases the total costs. Regulatory burden could be reduced by making a case to the European Commission that the ten year validity period within which public authorities have to upgrade public buildings is inefficient.

Aforementioned options are ways of implementing the EPBD using discretionary room to take proportionality into account. Actively pursuing such alternatives, either to reduce costs or to increase benefits, is therefore recommended. As stated before, a thorough study on both costs and benefits beforehand will give insight in the desirability of different policy options and can be used to support cases in discussions with the European Commission. In the final paragraph of each of the chapters in this report, more detailed recommendations to increase benefits and/or limit regulatory burden are presented.

Main conclusions in Dutch

Het Adviescollege Toetsing Regeldruk (ATR) heeft het Economisch Instituut voor de Bouw (EIB) gevraagd een onderzoek uit te voeren naar de implementatie van de Europese Richtlijn voor de energieprestatie van gebouwen (EPBD) van 2010 in nationale wetgeving in Nederland en vijf andere Europese landen (Denemarken, Duitsland, Engeland, Noorwegen en Portugal). Doel van de richtlijn is een reductie van de energieconsumptie van 20% en een vermindering van broeikasgassen van 20% in 2020 in vergelijking met 1990. Tevens wordt beoogd het aandeel hernieuwbare energie te verhogen tot 20% in 2020[38]. Doel van dit onderzoek is aanbevelingen te doen over het ontwerp van nationale wetgeving op het gebied van de energieprestatie van gebouwen, met inachtneming van de regeldrukeffecten, de baten van het beleid en de proportionaliteit van regeldruk en baten. Daarnaast wordt inzicht in de proportionaliteit van maatregelen verschaft door de regeldruk van de verschillende maatregelen te vergelijken met de relevante (sociale) baten. Tot slot worden aanbevelingen gegeven voor een proportionele implementatie van Europese richtlijnen op basis van de implementatie van de EPBD in de andere landen.

Regeldruk is expliciet meegenomen bij de implementatie van het systeem voor energielabels en de keuring van installaties in Nederland

Regeldrukeffecten zijn meegenomen bij het implementatieproces van het systeem voor energielabels en de keuringen van installaties in Nederland. Op het gebied van energielabels is voor een systeem gekozen met relatief lage kosten en eisen die naleving eenvoudig maken, in het bijzonder voor particuliere woningeigenaren. Om aan de EPBD-richtlijn te voldoen en regeldrukeffecten te beperken, werd in 2015 het vereenvoudigd energielabel geïntroduceerd samen met een controlesysteem. Het bestaande systeem waarbij huisbezoeken nodig waren, is tijdens het implementatieproces ook overwogen. Door hogere kosten is dit systeem als ongewenst gezien: het systeem van vereenvoudigde energielabels verminderde de verwachte kosten met ongeveer € 14 miljoen per jaar[39].

In Nederland en Noorwegen[40] is een vereenvoudigd energielabel voor woningeigenaren ingevoerd om aan de eisen van de EPBD te voldoen. In beide landen is voor dit systeem gekozen om de regeldrukeffecten voor het verkrijgen van een label zoveel mogelijk te beperken. Het label kan zowel in Nederland als Noorwegen online worden aangevraagd, alleen is er in Noorwegen geen tussenkomst van een deskundige zoals in Nederland. In Denemarken is het verkrijgen van een label mogelijk zonder bezoek van een deskundige ter plaatse voor woningen die minder dan 25 jaar geleden zijn gebouwd en sindsdien niet wezenlijk zijn veranderd. In de andere landen die zijn betrokken in dit onderzoek (Duitsland, Engeland en Portugal) is gekozen voor labels die worden afgegeven door deskundigen en waarvoor een bezoek van de betreffende woning vereist is. Als gevolg hiervan liggen de kosten van deze expert-labels aanzienlijk hoger dan voor de vereenvoudigde labels die in Nederland en Noorwegen worden afgegeven. De kosten variëren van gratis tot € 150 voor vereenvoudigde labels[41] ten opzichte van € 250 tot € 850 voor expert-labels. Tabel 1 geef een overzicht van de verschillende type labels in de betrokken landen.

[38] Deze doelstellingen gelden voor de EU als geheel en zijn dus niet van toepassing op het niveau van individuele lidstaten.

[39] SIRA Consulting (2014), Regeldrukeffecten vernieuwd energielabel voor woningen. Aangezien transacties in 2013 gebruikt zijn voor de berekeningen en het aantal transacties de jaren erna is gestegen, is de kostenbesparing in de praktijk hoger uitgevallen.

[40] Als niet-EU lid is Noorwegen niet verplicht om aan de EPBD te voldoen.

[41] Het vereenvoudigd label kosten in Denemarken € 150, terwijl de expert labels € 500 - € 700 kosten. In Noorwegen zijn de online labels gratis te verkrijgen en in Nederland bedragen de gemiddelde kosten ongeveer € 10.

Tabel 1	Implementatie van labels voor woningen en woongebouwen in de verschillende landen				
Denemarken	**Duitsland**	**Engeland**	**Nederland**	**Noorwegen**	**Portugal**
– EPC zonder huisbezoek (eengezins-woningen <25 jaar oud) – Label o.b.v. gemeten energie-verbruik (meergezins-huurwoning) – Expert-labels	– Expert-labels – Label o.b.v. gemeten energie-verbruik (alleen toegestaan voor een gebouwen die aan bepaalde eisen voldoen)	– Expert-labels – Appartementen: slechts één appartement hoeft bezichtigd te worden wanneer kan worden aangetoond dat deze vergelijkbaar is met de rest	– Vereen-voudigd energie-label (private woning-eigenaren) – Expert-label (sociale verhuur)	– Gratis online vereen-voudigd label (eenvoudig of gedetaill-eerd) – Expert-label (vrijwillig)	– Expert-label

Bron: EIB

Vanaf 2002 schrijft de richtlijn regelmatige keuring van verwarmings- en airconditioningsinstallaties vanaf een bepaalde grootte voor. In Nederland is de regeldruk van deze eis beperkt door voor verwarmingssystemen aan te tonen dat het bestaande systeem van vrijwillig onderhoud aan cv-ketels door particulieren voldoet. Voor airconditioningssytemen met een nominaal vermogen van minstens 12 kW werd een keuring geïntroduceerd als gevolg van de EPBD en in 2010 werd daar de verplichting van een keuringsrapport aan toegevoegd. In de praktijk leiden de inspecties, en in het bijzonder de keuringrapporten, tot kosten voor gebouweigenaren of gebruikers zonder dat dit effect heeft op energiebesparing. Als gevolg van deze beperkte baten is ervoor gekozen om niet actief te controleren of de inspecties plaatsvinden. Hierdoor is de naleving en de regeldruk in de praktijk beperkt.

Toegevoegde waarde van energieprestatiecertificaten lijken in de praktijk beperkt

Om de proportionaliteit van de Nederlandse implementatie van het energieprestatiecertificaat te kunnen beoordelen, moeten de baten van het systeem in kaart worden gebracht. Er zijn verschillende studies gedaan naar de effectiviteit van het energielabel in Nederland. In een tweetal studies wordt geconcludeerd dat het energielabel effect heeft op woningprijzen (niet gerelateerd aan energiebesparing)[42] en op hoe lang een woning op de markt wordt aangeboden[43]. Om de waarde van deze studies te beoordelen, is het nodig om te bepalen of deze effecten uitsluitend het resultaat zijn van het energielabel of dat hier andere factoren voor verantwoordelijk zijn (compositie-effecten). De methodologie van deze onderzoeken sluit compositie-effecten niet uit. Het CPB[44] heeft recentelijk literatuurstudie uitgevoerd en een mogelijke prijspremie onderzocht. Het instituut concludeert dat ‘een beter energielabel niet gepaard gaat met een prijspremie bij de scheidslijn tussen labels. De energie-efficiëntie is goed gekapitaliseerd en energielabels lijken, afgezien van wat er al beprijsd is in de markt, geen extra informatiewaarde te kennen’. Een aantal andere studies bevestigt het beeld dat er onvoldoende bewijs is dat een beter energielabel resulteert in een prijspremie die niet gerelateerd is aan de

[42] Brounen, D., Kok, N. (2011), On the economics of energy labels in the housing market, Journal of Environmental Economics and Management.

[43] Aydin, E., Correa, S.B., Brounen, D. (2019), Energy performance certification and time on the market, Journal of Environmental Economics and Management.

[44] CPB (2020), The information value of energy labels: Evidence from the Dutch residential housing market.

hogere energie-efficiëntie van de betreffende woning [45] [46] [47]. Het ontbreken van een dergelijke 'additionele' prijspremie is bevestigd in onze interviews met experts.

Een ander mogelijk effect van energielabels is het vergroten van bewustwording, waardoor gebouweigenaren geprikkeld worden om te investeren in energiebesparende maatregelen. Er is geen onweerlegbaar bewijs voor dit effect, maar twee studies gebaseerd op enquêtes suggereren dat energielabels een rol kunnen spelen in duurzaamheidsinvesteringen. Eén studie concludeert dat energielabels een zwakke invloed hebben op aankoopbeslissingen[48] en een andere studie gebaseerd op enquêtes[49] constateert dat 'het energielabel een positief effect heeft op bewustwording' en dat '10% van de gebouweigenaren die energiebesparende maatregelen hebben getroffen, dit niet zouden hebben gedaan zonder het energielabel'. Aan de andere kant geeft dezelfde studie aan dat 'slechts een klein aantal van de ondervraagden het energielabel als reden voor het nemen van energiebesparende maatregelen aandroeg, terwijl financiële overwegingen een veel prominentere rol spelen'. Uitgaande van deze onderzoeken kan een zeker positief effect van energielabels op bewustwording en het nemen van energiebesparende maatregelen niet worden uitgesloten.

In de afgenomen interviews worden met name andere redenen voor het investeren in energiebesparende maatregelen genoemd: wooncomfort en financiële prikkels worden als belangrijkste redenen aangedragen. Omdat de huidige vormgeving van het energie-prestatiecertificaat niet tot de gewenste resultaten heeft geleid[50], wordt er in verschillende landen nagedacht over hoe, met een andere inrichting van dit instrument, een groter effect op energiebesparing kan worden bereikt. De hiervoor genoemde studie van Kantar benadrukt de waarde van financiële prikkels. Sommige financiële instellingen gebruiken het energielabel om maximale hypotheekwaarden te berekenen en rentekortingen toe te kennen. Als deze condities een waarde vertegenwoordigen en een effect hebben, leiden zij tot een grotere vraag naar woningen met een beter label, stijgen de prijzen van deze woningen en wordt een prijspremie zichtbaar. Zoals eerder aangegeven, is deze prijspremie momenteel niet aanwezig, maar enig effect van gunstige condities kan niet worden uitgesloten in de toekomst, afhankelijk van de vormgeving. Aangezien financiële overwegingen de belangrijkste redenen zijn om te investeren in energiebesparende maatregelen en energielabels geen extra prijspremie tot gevolg hebben, lijkt het effect op gedrag per saldo in de praktijk beperkt. Vanuit dit perspectief is de keuze voor een vereenvoudigd, relatief goedkoop energielabelsysteem voor particuliere woningeigenaren gebalanceerd te noemen.

Terugkeer naar expert-labels leidt tot hogere kosten

De EPBD III van 2018 schrijft voor dat het energielabel moet worden gebaseerd op de primaire energievraag en moet worden uitgedrukt in kWh/m^2 per jaar met het oog op transparantie en vergelijkbaarheid tussen lidstaten. In Nederland is hiervoor een nieuwe rekenmethodiek ontwikkeld, de NTA 8800, waarbij de geometrie van het gebouw een meer prominente rol krijgt in de berekening van de energieprestatie van gebouwen. Voor private woningeigenaren bleek de opname van deze karakteristieken van hun woning te lastig, waardoor het energielabel bij het gebruik van de nieuwe methodiek vanaf 2021 alleen kan worden afgegeven door een expert naar aanleiding van een bezoek ter plaatse. Dit leidt tot een kostenverhoging voor particuliere

[45] Jessica Havlínová en Dorinth van Dijk (2019), Verplichte energielabels hebben positief effect op verduurzaming van huizen. ESB, 12 september, 2019, https://esb.nu/esb/20055699/verplichte-energielabels-hebben-positief-effect-op-verduurzaming-van-huizen.

[46] Olaussen, Oust and Solstad (2017), Energy Performance Certificates – Informing the Informed or the indifferent?, Energy Policy (2017), vol 111, p.246-254.

[47] PBL (2020), Woonlastenneutraal koopwoningen verduurzamen. The study mentions 'different studies on the effect of energy labels on value, show a fairly consistent result of limited value effects.'

[48] Evaluation of Directive 2010/31/EU on the energy performance of buildings, Commission Staff working document, 30 November 2016, SWD (2016) 408 final. Dit rapport refreert naar Murphy, L. (2014), The influence of the Energy Performance Certificate: the Dutch case.

[49] Kantar (2017), Onderzoek effect energielabel voor woningen.

[50] In Portugal en Duitsland wordt bijvoorbeeld overwogen om comfort mee te nemen in het certificeringssysteem, omdat het huidige systeem woningeigenaren onvoldoende stimuleert om in energiebesparende maatregelen te investeren. De gedachte is dat het benadrukken van verbeteringen ten aanzien van het wooncomfort, zoals bij het aanbrengen van extra isolatie, tot meer investeringen leidt dan wanneer de focus alleen op energiebesparing ligt.

en commerciële woningeigenaren van ongeveer € 33 miljoen per jaar in vergelijking tot een systeem met vereenvoudigde energielabels[51]. Indien voor iedere woning (circa 4,8 miljoen gebouwen)[52] een expert-label met meerkosten van € 150 ten opzichte van een vereenvoudigd label moet worden afgegeven, leidt dit tot additionele kosten van € 720 miljoen.

Gegeven deze kostenverhoging is het relevant om vast te stellen of particuliere woningeigenaren daadwerkelijk niet in staat zijn om zelf nauwkeurige informatie over geometrie van hun woning te verstrekken. Het feit dat dit niet kan, is gebaseerd op het geobserveerde gedrag van acht respondenten die gegevens moesten aanleveren ten behoeve van een vereenvoudigd energielabel, wat moeilijk als representatief kan worden beschouwd[53]. Daarnaast is het voor woningeigenaren lang niet altijd noodzakelijk om zelf de geometrie van hun woning op te meten, aangezien deze informatie vaak is opgenomen in de documentatie die overhandigd wordt bij de verkoop. Indien deze documentatie verloren is gegaan, kan dit eenvoudig bij de makelaar worden opgevraagd. Tot slot onderschat de studie de rol van experts bij het afgeven van vereenvoudigde energielabels. In de huidige situatie accordeert een expert de online aangeleverde informatie en aangenomen mag worden dat deze situatie ongewijzigd kan blijven. Een expert controleert de informatie, stelt vervolgvragen en geeft advies over hoe bewijs kan worden geleverd van bijvoorbeeld de aangebrachte isolatie en beglazing. Ook kan de expert een deel van de doorgegeven informatie controleren in bijvoorbeeld de BAG[54]. De studie constateert dat 'vragen die in eerste instantie onbekend of te complex zijn, met ondersteuning van een professionele adviseur wel beantwoord kunnen worden'. Op basis van deze conclusie lijkt het goed mogelijk om gebouweigenaren zelf de juiste informatie aan te laten leveren en experts deze gegevens op afstand te laten controleren om zo de kans op fouten te minimaliseren. Het feit dat er in Noorwegen een goed functionerend vereenvoudigd systeem bestaat, waarbij de energieprestatie is uitgedrukt in kWh/m^2 per jaar en geometrie onderdeel is van de door de eigenaar aangeleverde gegevens, onderstreept deze bevinding.

De tweede vraag die beantwoord dient te worden is: wat zijn de consequenties wanneer er incorrecte gegevens met betrekking tot de geometrie van een gebouw worden verstrekt en dit in een klein aantal gevallen niet door de 'online-expert' wordt opgemerkt? Volgens DGMR[55] kunnen onnauwkeurige metingen die 10% tot 20% afwijken van het werkelijke vloeroppervlak, leiden tot een afwijking in het energiegebruik van 7% tot 15%. Van deze onnauwkeurig gemeten woningen wordt als gevolg circa 30% tot 40% aan de verkeerde labelklasse toebedeeld. Doorgaans verschilt het energielabel van deze verkeerd ingedeelde woningen één labelklasse van de werkelijke energieprestatie. Met het oude systeem dat gebaseerd is op de Energie Index wordt ondanks foutieve metingen circa 93% van de gebouwen aan de juiste labelklasse toebedeeld. Om deze reden werd een vereenvoudigd energielabel op basis van de NTA8800 in vergelijking tot het huidige systeem niet nauwkeurig genoeg bevonden en is besloten om het expert-label te herintroduceren[56].

Op basis van interviews met experts kan worden geconcludeerd dat de ervaringen met de vereenvoudigde labels in de verschillende landen overwegend positief zijn. Over het algemeen is men van mening dat de labels een relatief goed en objectief beeld geven van de energieprestatie van woningen tegen beduidend lagere kosten. Uit expertinterviews blijkt dat het vereenvoudigd label mogelijk minder nauwkeurig is dan het energielabel waarvoor een

[51] In een in 2019 uitgevoerde studie, wordt de additionele jaarlijkse regeldruk voor huiseigenaren geschat op € 19,5 miljoen. Dit is echter gebaseerd op een te lag aantal jaarlijkse transacties. De oorspronkelijke calculatie staat in SIRA Consulting (2019) 'Lastenmeting wijziging energieprestatiemethode en inijking energielabels'. Het kostenverschil benadrukt het belang van juiste kosten/batenanalyses voor besluitvorming.

[52] Woningcorporaties gebruiken nu al on-site expert EPC's, aangezien de maximale huur gedeeltelijk afhangt van het expert EPC.

[53] RVO (2019), Overkoepelende rapportage uitgevoerde onderzoeken haalbaarheid Vereenvoudigd Energielabel (VEL) o.b.v. NTA 8800.

[54] Basisregistraties Adressen en Gebouwen, waarin bijvoorbeeld de oppervlakte van een gebouw is vermeld.

[55] DGMR (2019), Vereenvoudigd Energielabel NTA 8800.

[56] De studie van DGMR presenteert meer effecten van foutieve metingen, maar deze zijn beduidend kleiner dan de hier genoemde afwijking. Het is belangrijk om te vermelden dat DGMR heeft onderzocht of een vereenvoudigd label op basis van de NTA8800 met dezelfde nauwkeurigheid kan worden vastgesteld als in het huidige systeem. Dit bleek niet mogelijk, wat heeft geresulteerd in de beslissing om het expert label te herintroduceren.

huisbezoek noodzakelijk is. Echter geven de geïnterviewden ook aan dat bij expert-labels het oordeel van verschillende experts van elkaar kan afwijken.

Uit bovenstaande analyse rijst de vraag of de herintroductie van het expert-label wenselijk is. De aanzienlijk hogere kosten moeten worden afgezet tegen de waarde van het label. Zoals eerder opgemerkt, kan een zeker positief effect van het energielabel om in verduurzaming te investeren op basis van eerder onderzoek niet worden uitgesloten. Er is hierbij echter geen reden om aan te nemen dat deze effecten duidelijk groter zijn bij gebruik van een expert-label dan bij gebruik van het huidige online label. Bij de internationale vergelijking die in het kader van het onderzoek is uitgevoerd, is daarnaast gebleken dat een online label goed kan worden toegepast onder de nieuwe eis om energiegebruik uit te drukken in kWh per vierkante meter per jaar. Noorwegen maakt al gebruik van een dergelijk systeem. Momenteel zijn er geen actieve beleidsmaatregelen waarvoor het energielabel als uitgangspunt wordt genomen[57], wat betekent dat het (potentiële) gebrek aan nauwkeurigheid geen grote gevolgen heeft. Bovendien zijn expert-labels ook niet altijd accuraat. Gezien deze punten en het grote kostenverschil tussen beide labels, concludeert het EIB dat behoud van het huidige online labelsysteem de juiste route kan zijn.

Wanneer er twijfel bestaat over de nauwkeurigheid van het vereenvoudigd label, kan dit worden geëvalueerd door voor een deel van de afgegeven vereenvoudigde labels ook verschillende expert-labels te laten opstellen (bijvoorbeeld drie per woning) en de uitkomsten van al deze labels met elkaar te vergelijken. Het lijkt de moeite waard om de mate waarin de uitkomsten verschillen op deze manier te analyseren. Zodoende kan, gebaseerd op de verschillen, de kwaliteit van het online label worden verbeterd en de behoefte aan een nauwkeuriger expert-label worden bepaald. In de beslissing of een nauwkeuriger label wenselijk is, moet rekening worden gehouden met het feit dat de kosten van een expert-label tien tot twintig keer hoger liggen dan voor een vereenvoudigd label en de opbrengsten hiertoe in verhouding zouden moeten staan.

Mogelijkheid om energielabels te gebruiken voor beleid kan worden verkend

Het bestaande beleid gericht op energiebesparing maakt geen gebruik van energielabels, terwijl er wel kosten zijn gemaakt om het systeem te introduceren. In relatie tot energiebesparing zou het energielabel goed kunnen functioneren als beleidsinstrument. De redenering hierachter is tweeledig. Ten eerste zijn energielabels verplicht volgens Europese wetgeving en als gevolg is er een systeem in werking gesteld voor het bepalen van de energieprestatie van gebouwen dat naar verwachting voor langere periode gebruikt zal worden. Het aanwenden van een gevestigd systeem kan naar verwachting de regeldrukeffecten van nieuw beleid voor het besparen van energie beperken. Ten tweede geven zowel vereenvoudigde als expert-labels een relatief goede indicatie van de energieprestatie van gebouwen, wat een goede basis kan bieden voor het ontwikkelen van beleid.

In Engeland en Nederland zijn minimumeisen geïntroduceerd op basis van de bestaande systematiek voor de utiliteitsbouw. Subsidieregelingen in Nederland en Portugal zijn in het verleden gebaseerd op de labels en in Portugal en Engeland worden incidenteel belasting-voordelen gegeven voor woningen met een beter energielabel door lokale overheden. Deze voorbeelden tonen aan dat labels goed gebruikt kunnen worden voor aanvullend beleid om energiebesparing te realiseren. Wanneer een koppeling tussen beleid en het energielabel wordt gemaakt, neemt het belang van betrouwbaarheid en nauwkeurigheid toe. In dit geval is het aan te bevelen om de implicaties van het behouden van een vereenvoudigd label verder te onderzoeken, bijvoorbeeld met de in de vorige paragraaf geschetste methodiek van huisbezoeken.

Momenteel is er geen reden om aan te nemen dat gebouweigenaren moedwillig verkeerde informatie over de energieprestatie van hun woning verstrekken. Indien er twijfel is over de fraudegevoeligheid van vereenvoudigde labels in combinatie met bijvoorbeeld subsidie-

[57] Het woningwaarderingsstelsel en de RVV maakt gebruik van EPC's, maar alleen expert EPC's worden hiervoor gebruikt.

regelingen, zal een efficiënt kwaliteitscontrolesysteem noodzakelijk zijn. Handhaving kan plaatsvinden door middel van steekproefsgewijze controle en hoge sancties. Hoge boetes hebben een ontmoedigend effect en bevorderen naleving zonder tot een grote toename van bestuurlijke lasten voor overheden te leiden. Om geschillen over toegekende labels en de negatieve effecten van onnauwkeurige metingen door woningeigenaren in het geval van vereenvoudigde labels te beperken, kan een minder gedetailleerd systeem uitkomst bieden. Het verminderen van het aantal labelklassen (bijvoorbeeld 'uitstekend-goed-voldoende-onvoldoende' in plaats van A-G) kan in dit scenario gunstig zijn.

Tot slot kan de introductie van vereenvoudigde labels voor sociale huurwoningen worden overwogen. Momenteel wordt dit in de praktijk niet gedaan als gevolg van het 'woningwaarderingsstelsel' dat sociale verhuurders een prikkel biedt om een expert EPC aan te vragen, aangezien deze een rol speelt bij het bepalen van de huur voor sociale huurwoningen. Aangezien expert EPC's voor woningcorporaties (de grootste groep sociale verhuurders) ongeveer acht keer zo duur zijn als vereenvoudigde labels en gezien het feit dat ervaringen met vereenvoudigde labels in het algemeen positief zijn, lijkt het invoeren van vereenvoudigde labels voor sociale huurwoningen een meer proportionele maatregel. Dit is wel afhankelijk van de overige regelgeving die hierdoor mogelijk wordt geraakt en nauwkeurigheid van het label. Regeldruk en baten die het gevolg zijn van aanpassing van bestaande regels moeten worden meegenomen in de overweging.

Aanscherping naar BENG leidt tot hogere regeldruk

De EPBD van 2010 schrijft voor dat de lidstaten een definitie opstellen van Bijna-Energie-Neutrale Gebouwen (BENG) als minimumeis voor nieuwe gebouwen in 2020. De EPBD biedt landen veel ruimte bij het vaststellen van de BENG-eisen, aangezien ze geen definitie voorschrijft. Bovendien hoeven minimumeisen niet strenger te zijn dan kostenoptimale niveaus: als kostenoptimaliteit niet haalbaar is, hoeven eisen niet te worden aangescherpt. Het is wel verplicht om kWh/m^2 per jaar als indicator voor BENG-eisen te hanteren.

In de jaren tot 2020 hebben in alle landen die in dit onderzoek zijn onderzocht, tussentijdse aanscherpingen van de minimumeisen plaatsgevonden. Het vaststellen van minimumeisen heeft zich op gelijke wijze voorgedaan in de verschillende landen. Hiervoor zijn in alle landen kostenoptimaliteitsstudies uitgevoerd. Duitsland, Engeland en Denemarken hebben kostenoptimale minimumeisen ingevoerd tot 2020, waar Nederland en Portugal kosten-optimaliteit hebben losgelaten[58]. De aanscherping van de minimumeis in Nederland van een EPC van 0,6 naar 0,4 in 2015 was strenger dan het kostenoptimale niveau. De gemiddelde additionele initiële investeringen voor woningen namen als gevolg toe met ongeveer € 8.500[59]. Tussen 2015 en 2019 zijn ongeveer 60.000 woningen per jaar gebouwd waarvoor deze eisen golden, wat heeft geleid tot additionele kosten van ongeveer € 500 miljoen per jaar. Uit de kostenoptimaliteitsstudie blijkt dat een tot tweede derde van die investering niet wordt terugverdiend op basis van theoretische energiebesparingen[60] [61] en levenscycluskosten. In Duitsland en Engeland, waar de minimumeisen zijn gesteld op kostenoptimale niveaus, kan de volledige investering worden terugverdiend door een afname van de energierekening. De jaarlijkse CO_2 besparing als gevolg van de aanscherping bedraagt 43.000 ton bij nieuwbouw van 60.000 woningen per jaar. Dit is ongeveer 0,2% van de totale CO_2 uitstoot van de gebouwde omgeving in 2015.

[58] In Denemarken was de minimumeis in 2010 niet kostenoptimaal aangezien de bouwindustrie onvoldoende tijd had zich voor te bereiden op de nieuwe eisen. Met de introductie van kostenoptimale eisen in 2015 is hiervoor gecorrigeerd. In 2020 is kostenoptimaliteit niet meer van toepassing door lagere energieprijzen en belastingen.

[59] Gewogen gemiddelde van de additionele investeringskosten van de aanscherping van EPC 0,6 naar 0,4 zoals berekend door W/E adviseurs en Arcadis. Levenscycluskosten liggen vermoedelijk hoger, maar gehanteerde herinvesteringen en onderhoudskosten zijn niet gepresenteerd in de studie.

[60] W/E adviseurs en Arcadis (2013), Aanscherpingsstudie EPC woningbouw en utiliteitsbouw 2015.

[61] In de berekeningen worden theoretische energiebesparingen gecalculeerd. Er zijn indicaties dat deze besparingen in de praktijk lager uitvallen, zie bijvoorbeeld Majcen (2016).

Additionele investeringen die samenhangen met BENG-eisen worden niet terugverdiend

Met de implementatie van BENG-eisen, wordt de ambitie om energie te besparen vastgelegd. Het is vanuit dit oogpunt interessant te bezien wat een verdere aanscherping van de EPC-eis zou betekenen. Een hypothetische aanscherping van de EPC van 0,4 naar 0,2 zou een gemiddelde stijging van € 15.000 in bouwkosten voor een woning met zich meebrengen volgens bouwbedrijven. Deze stijging is twee maal zo groot als de eerdere stijging bij een aanscherping van EPC 0,6 naar 0,4. Van deze additionele kosten wordt ongeveer 75% niet terugverdiend. Dit voorbeeld toont aan dat een verdere aanscherping niet kostenefficiënt is.

Vanwege de verplichting om BENG-eisen in kWh/m² per jaar uit te drukken, heeft Nederland de EPC-standaard losgelaten en zijn berekeningsmethoden aangepast om aan te sluiten bij de NTA 8800. Daarnaast is in 2018 de 'wet VET' ingevoerd. Deze wet kent haar oorsprong in 'De Energieagenda'[62] en geeft aan dat veranderingen in regelgeving nodig zijn om de energietransitie te stimuleren[63]. De 'wet VET' is formeel niet aan de EPBD verbonden en bepaalt dat aardgas niet langer gebruikt mag worden als energiebron in nieuwbouw vanaf juli 2018. De introductie van de 'wet VET' en de verandering van energieprestatiecoëfficiënt (EPC) naar kWh/m² per jaar als indicator compliceren de vergelijking russen nieuwe en oude standaarden, aangezien indicatoren en berekeningsmethoden verschillen.

In 2019 is de kostenoptimaliteitsstudie uitgevoerd door DGMR[64], welke de kostenoptimaliteit heeft berekend gegeven de eis dat aardgas niet als energiebron gebruikt kan worden. Daarnaast zijn nieuwe berekeningswijzen gehanteerd, gebaseerd op de NTA 8800, met kWh/m² per jaar als indicator. Het resultaat van de studie was een minimumeis van 30 kWh/m² per jaar voor primair energiegebruik voor grondgebonden woningen en 50 kWh/m² per jaar voor appartementen. Deze eisen zijn als kostenoptimaal vastgesteld wanneer aardgas wordt uitgesloten.

Uit de kostenoptimaliteitsstudie kan worden geconcludeerd dat, als gevolg van zowel BENG-minimumeisen als de 'wet VET', levenscycluskosten toenemen met ongeveer € 22.500[65], waarvan ongeveer de helft (€ 11.750) niet terugverdiend zal worden[66]. Deze kosten kunnen echter niet volledig aan de EPBD worden toegekend. DGMR en RVO[67] concluderen dat 5% tot 35% van de netto levenscycluskosten toe te wijzen is aan de EPBD, ofwel € 590 tot € 4.100 per woning. Gebaseerd op 60.000 nieuwbouwwoningen per jaar, brengt de maatregel jaarlijks € 35,5 tot € 247 miljoen aan kosten met zich mee, aanvullend op de kosten van de eerdere EPC-aanscherping in 2015. De jaarlijkse CO_2 besparing als gevolg van de BENG-eisen en de 'wet VET' is vergelijkbaar met de besparing als gevolg van de aanpassing van de EPC van 0,6 naar 0,4 en bedraagt 44.000 ton bij nieuwbouw van 60.000 woningen per jaar. De kosten per vermeden ton CO_2 als gevolg van zowel de 'wet VET' als BENG-standaarden bedragen ongeveer € 1.000, wat aanzienlijk is vergeleken met andere beleidsmaatregelen[68].

De berekening laat zien dat de stap van EPC 0,4 in 2015 naar 30 of 50 kWh/m² per jaar niet kostenoptimaal is en dat de 'wet VET' voor een groot deel verantwoordelijk is voor de stijging van netto levenscycluskosten. Figuur 1 toont de resultaten van de berekening van referentie-

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[62] Ministerie van Economische Zaken (2016), Energieagenda: Naar een CO_2-arme energievoorziening.

[63] Wet van 9 april 2018 tot wijziging van de Elektriciteitswet 1998 en van de Gaswet (voorgang energietransitie), Stb. 2018, 109.

[64] Kostenoptimaliteitsstudie NTA8800 Woningbouw en Utiliteitsbouw. DGMR Bouw (2019).

[65] Levenscycluskosten zijn initiële investeringen, herinvesteringen en onderhoudskosten.

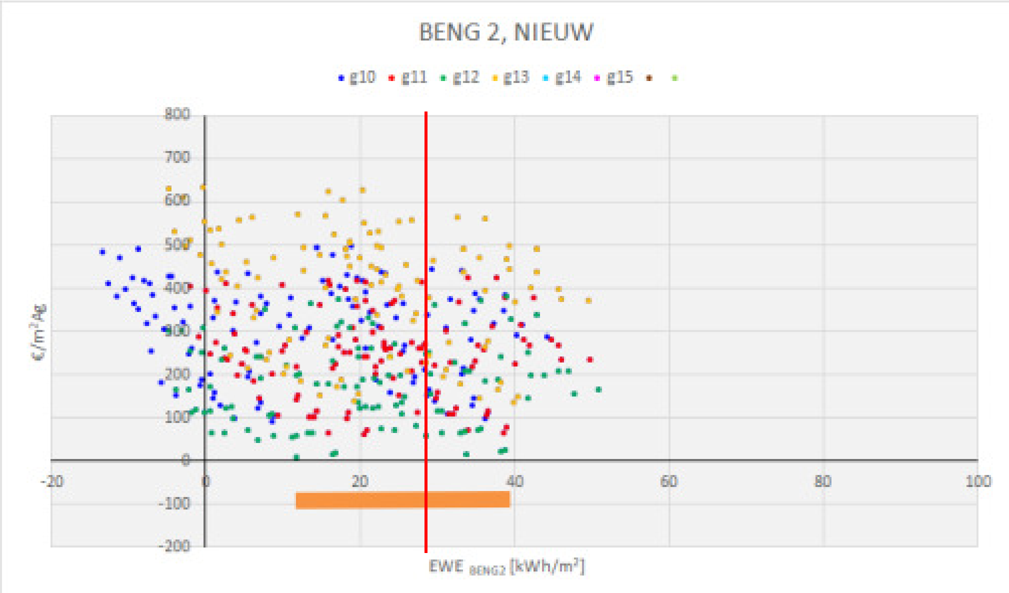
[66] DGMR Bouw (2019), Kostenoptimaliteitsstudie NTA8800 Woningbouw en Utiliteitsbouw. Gewogen gemiddelde van de additionele initiële investeringskosten, herinvesteringen en onderhoudskosten en baten (energiebesparing en restwaarde) van de 20 maatregelpakketten met de laagste netto contante levenscycluskosten.

[67] SIRA Consulting (2019), Effectmeting wijziging Bouwbesluit 2012. In dezelfde studie concludeert SIRA dat de gemiddelde additionele netto levenscycluskosten voor woningen ongeveer €7.600 bedragen. Vermoedelijk is bij de berekening gebruik gemaakt van de maatregelpakketten met de laagste kosten en van referentiegebouwen met lage netto levenscycluskosten.

[68] ECN & PBL (2016), Kostenefficiëntie van beleidsmaatregelen ter vermindering van broeikasemissies.

gebouwen zoals weergegeven in de kostenoptimaliteitsstudie voor grondgebonden woningen[69]. Elke gekleurde stip vertegenwoordigt een ander gebouwtype waarop maatregelpakketten worden geprojecteerd. Deze energiebesparende maatregelpakketten leiden tot primair energiegebruik (x-as) en bijbehorende additionele netto kosten per vierkante meter (y-as). Naar links bewegen langs de x-as impliceert strengere eisen. Aangezien de 'wet VET is meegenomen in de figuur, is aardgas geen onderdeel van de puntenwolk. De huidige eis ligt op 30 kWh/m² per jaar.

Figuur 1 **Additionele netto levenscycluskosten en energiegebruik in kWh/m² per jaar voor referentiewoningen**



Bron: RVO

Uit de figuur kan worden geconcludeerd dat er geen duidelijk kostenoptimaal punt te identificeren is. Deze conclusie wordt ook door RVO getrokken. De figuur roept een aantal vragen op. Ten eerste is in eerdere onderzoeken een relatie vastgesteld tussen kosten en energiegebruik: lager energiegebruik gaat gepaard met (exponentieel) stijgende kosten, zoals bijvoorbeeld ook zichtbaar was bij de aanscherping van EPC 0,6 naar 0,4 en de (hypothetische) aanscherping van EPC 0,4 naar 0,2. Deze relatie ligt voor de hand: het verminderen van het energiegebruik van een energiezuinige woning is duurder dan het verminderen van het energiegebruik van een energie-onzuinige woning[70]. Deze relatie tussen kosten en energiegebruik lijkt afwezig in bovenstaande figuur, wat opvallend is te noemen. Ten tweede verklaart het gebruik van verschillende maatregelpakketten en verschillende gebouwtypen de brede uitkomsten van figuur 1. Uit de uitkomsten valt moeilijk een conclusie te trekken en de resultaten zijn moeilijk te vergelijken. Gegeven deze uitkomsten is het ingewikkeld om kosten en baten toe te wijzen aan de 'wet VET' en de EPBD. In dit licht roept de toewijzing van 5% tot 35% van de gestegen netto kosten aan de EPBD vragen op. Tot slot suggereren de data dat gedifferentieerde eisen voor verschillende woningen kostenefficiënter is dan het stellen van minimumeisen voor alle woningen aan de ene kant en alle appartementen aan de andere kant.

[69] RVO (2019), Advies BENG eisen woningbouw.

[70] In de economie staat dit bekend als de wet van de afnemende meeropbrengsten

De additionele energie- en CO_2-besparing van BENG-gebouwen ten opzichte van gebouwen met een EPC van 0,4 zijn beperkt, waardoor de baten en netto contante waarden bij financieel-economische en sociaaleconomische berekeningen dicht bij elkaar liggen. Om deze reden kan ook vanuit maatschappelijk oogpunt worden geconcludeerd dat het niet kostenefficiënt is om energiebesparing te realiseren door aanscherping van minimumprestatie-eisen voor gebouwen.

Bij het definiëren van BENG-eisen, heeft Portugal BENG strenger gesteld dan kostenoptimaal en in Nederland zijn BENG-eisen in combinatie met de 'wet VET' niet kostenoptimaal. In Engeland, Denemarken en Duitsland worden minimumeisen voorlopig op het kostenoptimale niveau gehouden[71]. De verschillende definities van BENG, de keuzes van de verschillende landen en het daaraan gerelateerde (gebrek aan) kostenoptimaliteit zijn een direct effect van de discretionaire ruimte die de lidstaten gebruiken en nationale beleidskeuzes aangaande wet- en regelgeving. De implementaties in Engeland, Duitsland en Denemarken hebben tot lagere lasten geleid door vast te houden aan kostenoptimale niveaus.

De kostenoptimaliteit van de 'wet VET' zelf is geen onderwerp geweest van onderzoek. Gezien de aanzienlijke toename van nieuwbouwkosten die waarschijnlijk toe te wijzen is aan de 'wet VET', is dit opvallend. Daarbij zijn er nog aanzienlijke kostenoptimale investeringen mogelijk in de bestaande voorraad die op een efficiëntere wijze bijdragen aan energiebesparing. Concluderend strekt het tot de aanbeveling om kosten-batenanalyses standaard uit te voeren waar het gaat om energiebesparingsmaatregelen en -eisen. Dit betekent niet dat de mogelijkheid om eisen te overwegen die niet kosten-efficiënt zijn, wordt uitgesloten, maar het maakt de invloed van maatregelen op lastendruk wel transparanter.

Uit interviews is gebleken dat het besluitvormingsproces dat heeft geleid tot de Nederlandse definitie van BENG en tot de aanscherping van de EPC naar 0,4 in 2015, weinig transparant was. Kostenoptimaliteitsstudies die aantonen dat de aanscherping van de EPC niet kostenoptimaal was, waren op dat moment beschikbaar. Uit de interviews kan worden opgemaakt dat stakeholdercommissies zijn betrokken, maar dat hun invloed beperkt was aangezien de ambitie om eisen aan te scherpen sterk naar voren kwam. Meer transparantie in het besluitvormingsproces kan bijdragen aan een beter begrip voor beslissingen en het draagvlak voor beleid vergroten.

Regeldruk vaak onderschat in ex ante studies

In ex ante studies worden regeldrukberekeningen gemaakt ten behoeve van beleidswijzigingen. In deze studie is een poging gedaan om geschatte en feitelijke regeldrukeffecten in kaart te brengen. Deze vergelijking is in de praktijk ingewikkeld gebleken, aangezien integraliteit vaak ontbreekt, bepaalde kostenposten niet zijn meegenomen in ex ante studies en het in de praktijk niet eenvoudig is kosten aan een enkele wet of regel toe te wijzen. Voor de verschillende eisen van de EPBD die in deze studie aan de orde komen, vergelijkt tabel 2 de verwachte en feitelijke regeldrukkosten waar dit mogelijk bleek. Initiële kosten zijn eenmalig, structurele kosten doen zich jaarlijks voor[72].

[71] Noorwegen, als niet-EU lid, heeft geen BENG-eisen gesteld, aangezien het land de ervaringen van andere lidstaten af wil wachten en hiervan wil leren. In Denemarken waren minimumeisen kostenoptimaal in 2015. Als gevolg van lagere energieprijzen en belastingen, is kostenoptimaliteit momenteel niet meer van toepassing.

[72] Een volledige verdeling van initiële en structurele kosten wordt gegeven in de volgende hoofdstukken. Kosten voor het tonen van het energielabel zijn gerekend onder initiële kosten omdat dit ook zo was geclassificeerd bij de verwachte regeldruk. Op deze manier kon een consistente vergelijking worden gemaakt. Echter, deze kosten worden elke 10 jaar of na het aanvragen van een nieuw label opnieuw gemaakt.

Tabel 2 **Overzicht van verwachte en feitelijke regeldruk**

Eis	Kostensoort	Verwachte regeldruk	Feitelijke regeldruk[1]
Energielabels	Initieel	€ 21.000.000	€ 21.000.000
	Structureel	€ 11.000.000	€ 17.000.000
Minimumeisen[2]	Initieel	€ 3.000.000	€ 40.000.000
Inspectie van technische systemen	Initieel	NA	€ 1.700.000
	Structureel	NA	€ 34.000.000

1 De feitelijke regeldruk is de regeldruk bij volledige naleving. Aangaande energielabels en minimumeisen zijn de kosten vrijwel gelijk in praktijk en theorie. Aangaande de inspectie van technische systemen, valt de regeldruk in de praktijk lager uit door de afwezigheid van een effectief controlesysteem.
2 Exclusief nalevingskosten van EPC-aanscherpingen

Bron: EIB

Voor de energielabels komen verwachte en feitelijke regeldruk overeen, echter zijn de kosten van kennisname van regelgeving in de praktijk lager en bleek het weergeven van het label in gebouwen in de praktijk duurder. Structurele kosten blijken in de praktijk hoger, voornamelijk door een hoger aantal transacties waar een label voor nodig is. Voor particuliere woning-eigenaren werd in ex ante studies uitgegaan van 67.000 verkochte woningen in 2013. In de praktijk is het aantal transacties aanmerkelijk hoger gebleken dan in 2013 aangezien het aantal transacties zich in dat jaar op het laagste punt van de afgelopen 25 jaar bevond. De feitelijke berekeningen gaan uit van ongeveer 130.000 transacties door private huiseigenaren van bestaande woningen. Dit betreft het gemiddelde van de afgelopen tien tot twintig jaar. Lage transactieaantallen werden ook toegepast bij commerciële huiseigenaren en project-ontwikkelaars.

De minimumeisen zijn in de praktijk aanzienlijk duurder gebleken. Aangaande de EPC-aanscherpingen in 2010 en 2015 gezamenlijk, is in ex ante studies uitgegaan van een half uur voor kennisname van regelgeving voor een bouwbedrijf. Uit interviews is gebleken dat kennisname ongeveer een dag kost, met aanmerkelijk hogere regeldrukkosten tot gevolg. Voor inspectie van technische systemen zijn geen ex ante studies uitgevoerd om regeldruk te bepalen.

De bestudeerde onderzoeken aangaande regeldruk presenteren uitsluitend de kosten van verschillende beleidsopties zonder naar de potentiële baten te kijken. Dit kan leiden tot suboptimale beslissingen wanneer er duurdere opties voor handen zijn die grote (maatschappelijke en/of financiële) baten kennen[73]. In dat geval zal de goedkoopste optie gekozen worden, waar vanuit proportionaliteit met in acht name van kosten en baten een andere optie de voorkeur heeft. Daarnaast is uniformiteit tussen studies wenselijk. In de kosten-optimaliteitssstudie van 2013 worden initiële investeringen apart weergegeven, maar worden levenscycluskosten niet gespecificeerd, waar dit in de studie in 2018 wel gebeurt. Het gebruik van levenscycluskosten en -baten en een specificatie van deze posten vergroot de transparantie voor beleidsmakers. Tot slot is de accuraatheid een aandachtspunt. Door consistent gebruik van transactiedata uit 2013, zijn jaarlijkse voordelen van een VEL onderschat in 2015 en zijn de kosten van herintroductie van een expert-label als gevolg van de NTA 8800 met ongeveer 40% onderschat in 2019.

[73] Appendix A geeft weer hoe een kwantitatieve analyse van de proportionaliteit van beleidsmaatregelen er uit zou kunnen zien (in het Engels).

Discretionaire ruimte kan actief worden opgezocht om regeldruk verder te beperken

Het systeem van vereenvoudigde energielabels dat Nederland en Denemarken de afgelopen jaren hebben toegepast om te voldoen aan de eisen van de richtlijn is een voorbeeld van het actief opzoeken van discretionaire ruimte. Een dergelijk systeem werd niet voorgesteld in de EPBD, maar doordat deze landen actief hebben gezocht naar alternatieve manieren om de richtlijn te implementeren, hebben ze de regeldruk weten te beperken. De Europese Commissie biedt landen de mogelijkheid om met alternatieve maatregelen te voldoen aan de eisen van de richtlijn zolang aangetoond kan worden dat deze minstens dezelfde effecten hebben als de voorgeschreven eisen.

Er zijn meer voorbeelden bekend van manieren waarop landen de richtlijn anders hebben geïmplementeerd dan voorgeschreven. In Denemarken is er bijvoorbeeld geen eis om bij grootschalige renovaties te bouwen volgens een geldende minimumeis, aangezien het land heeft aangetoond dat dit gebouweigenaren zou ontmoedigen om überhaupt maatregelen te nemen. Dit impliceert dat, wanneer kan worden aangetoond dat alternatieve maatregelen resulteren in grotere energiebesparing en/of lagere regeldrukeffecten, landen de mogelijkheid hebben een onderbouwde claim in te dienen bij de Europese Commissie en af te wijken van de richtlijn.

Een soortgelijk voorbeeld van hoe de regeldruk is beperkt, betreft de inspecties van technische installaties: geen van de landen in deze studie heeft keuringen geïmplementeerd voor verwarmingssystemen. Landen hebben met succes beargumenteerd dat het bestaande of een alternatief systeem efficiënter is in het behalen van de doelstelling van de EPBD tegen lagere kosten.

Engeland en Portugal hebben de richtlijn relatief kostenefficiënt geïmplementeerd aangaande utiliteitsgebouwen. In Engeland zijn eigenaren van utiliteitsgebouwen niet verplicht de aanbevelingen in het label om energie te besparen te nemen binnen de geldigheidsduur van het label. Deze maatregel is kostenverlagend aangezien hierdoor geen extra renovaties plaatsvinden of geplande renovaties versneld moeten worden uitgevoerd. In Portugal geldt de eis om het label op te hangen in utiliteitsgebouwen die geregeld door het publiek worden bezocht alleen voor gebouwen die groter zijn dan 500 m^2 in plaats van de voorgeschreven 250 m^2. Er lijkt derhalve ook op deze gebieden discretionaire ruimte te bestaan.

In de praktijk heeft de Europese Commissie lidstaten meer discretionaire ruimte gegeven dan initieel uit de richtlijn blijkt. Dit onderschrijft de noodzaak voor landen om kritisch te kijken naar de eisen in de richtlijn en actief manieren te ontwikkelen om op een kostenefficiënte manier en zoveel mogelijk binnen bestaande kaders invulling te geven aan de eisen. In Nederland, bijvoorbeeld, leidt de geldigheidsduur van energielabels van tien jaar tot extra regeldrukeffecten, aangezien nieuwe labels moeten worden uitgegeven wanneer geen aanpassingen aan het gebouw hebben plaatsgevonden. Regeldruk kan mogelijk worden beperkt door alleen een nieuw energielabel te vereisen wanneer aanpassingen aan gebouwen zijn gedaan die van invloed zijn op de energieprestatie. Hiervoor zou bijvoorbeeld met de Europese Commissie een lijst vastgesteld kunnen worden van aanpassingen aan gebouwen waarna een nieuw energielabel vereist is. Daarnaast valt de eis voor eigenaren van publieke gebouwen om de kostenefficiënte maatregelen van het energielabel te nemen binnen tien jaar vaak niet samen met renovatiecycli (meestal 30 jaar). Als gevolg moeten additionele investeringen plaatsvinden of investeringen naar voren worden gehaald, met hogere kosten tot gevolg. Regeldruk kan worden beperkt door bij de Europese Commissie aan te tonen dat de geldigheid van tien jaar voor een label leidt tot inefficiënte investeringen.

De hiervoor genoemde mogelijkheden zorgen voor een implementatie van de EPBD waarbij discretionaire ruimte wordt gebruikt om de proportionaliteit van maatregelen te verbeteren. Het actief ontwikkelen van dergelijke strategieën om de regeldruk te beperken of om de baten van het beleid te vergroten, is daarom aan te bevelen. Zoals eerder aangegeven geeft een degelijke ex ante studie naar kosten en baten inzicht in de wenselijkheid van verschillende beleidsopties en kan een dergelijke studie worden gebruikt om hierover in gesprek te gaan met de Europese commissie. In de laatste paragraaf van elk hoofdstuk van dit rapport worden meer aanbevelingen gedaan om baten te vergroten en/of regeldruk te beperken.

1 Introduction

This study focuses on the implementation of the 2010 recast of the European Energy Performance of Building Directive (EPBD) into national legislation in the Netherlands. The EPBD is part of European energy policy and was introduced in 2002 (as directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002). It seeks to improve the energy performance of buildings and stimulate the use of technical building systems that use less energy without negatively affecting the quality of the indoor climate and a number of other building requirements. In 2010 a recast of the directive was established, because it was deemed necessary to lay down more concrete actions to achieve a greater share of the unrealized potential for energy savings in buildings (Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010). In the recast of 2010, the objective of the EPBD to reduce energy consumption by 20% in 2020, to reduce emissions of greenhouse gas by at least 20% and to produce 20% renewable energy was first set[74]. Also, there was a greater focus on cost-optimal levels of investments. In 2018 the directive has been amended again, mostly to stimulate the installation of smart self-regulating devices and facilities for electric vehicles. The directive needs to be transposed into national legislation of the EU member states within a given term after its introduction. In many cases it acts as a minimum requirement and gives national governments room for discretion in the way they implement it.

The aim of this study is to give recommendations on the design of legislation concerning the energy performance of buildings given the effects on regulatory burden and associated benefits and its proportionality. Moreover, the study aims to assess the anticipated and actual regulatory burden based on how the implementation of the EPBD has worked out in practice. Furthermore, insights into the proportionality of the implemented measures will be provided by evaluating the additional regulatory burden relative to the associated (social) benefits. The lessons learned in this study aim to provide ATR with input for recommendations on future legislation. Therefore, the following five main themes from the directive have been selected:

- System of energy performance certificates
- Minimum energy performance requirements
- Inspection of technical building systems
- Financial instruments
- Independent control system

The next four chapters will describe the first four of these main themes. The independent control system regarding these measures will be described in each of the chapters. The following questions will be answered:

- What does the directive prescribe in the recast in 2010 and how does this relate to the 2002 directive and the amendment of 2018?
- Where does the directive leave member states room for discretion?
- How has the directive been implemented in national legislation in the Netherlands?
- What alternatives have been considered during the process of implementation?
- What is the experience with the legislation in practice and what lessons can be learned regarding the efficiency of the legislation in achieving its target?
- What is the regulatory burden of the Dutch implementation of the directive and what are the benefits in terms of reduction of energy consumption and greenhouse emissions? What can be concluded about the proportion of these costs and benefits?
- How is the directive implemented in other European countries and what lessons can be learned from these implementations?

[74] These objectives are not tied to objectives at the level of member states.

1.1 Research method

The answers to the above questions are answered through thorough desk research of the country reports and other available studies of each of the countries included in this study. Furthermore, expert interviews have taken place. In the Netherlands a wide range of parties that have been involved with the implementation of the EPBD in the national context have been contacted. In the other countries we have aimed to speak with at least the ministry responsible for the national implementation of the EPBD (in many cases internal affairs) or delegated agencies (e.g. ADENE in Portugal), an involved consumer organization and a representative organization for construction companies. Where this was not possible, we have aimed to obtain the needed information through affiliated parties. Appendix I gives an overview of the organizations included in the interviews.

The choice of the different countries included in this study follows from both the research inquiry from the Dutch Advisory Board on Regulatory Burden and proposals from the EIB as a result from our initial research for the project. The good relations of the Dutch advisory Board on Regulatory Burden in Germany, Norway and the UK were reason to include these countries. Denmark and Portugal were added as these countries provided an interesting point of view from the specific implementation in these countries. Denmark actively included the construction and building components sectors with the determination of the minimum energy performance requirements. While Portugal has a large financial instrument in place that is based on energy performance certificates and provides a different perspective on energy efficiency as a consequence of the different climate as compared to Northern European countries.

2 System of energy performance certificates

The aim of this chapter is to provide insight in the regulatory burden of the system of energy performance certificates as required by the EPBD as it is implemented in the Netherlands. To that aim, the chapter first presents the requirements regarding the system of energy performance certificates in the EPBD of 2002 and the recast of 2010. Thereafter the implementation in the Netherlands is described after which the expected and actual regulatory burden are presented. Then, a comparison will be made with the systems in 5 other European countries (Denmark, England, Germany, Norway and Portugal). Finally, the current developments as a consequence of the EPBD of 2018 are posed and the conclusions and recommendations are formulated.

2.1 What does the directive prescribe?

EPBD 2002: system of certification required
In 2002 it was established that member states should install a system of certification for the energy performance of buildings. For buildings or building units that are constructed, sold or rented out to a new tenant, an energy performance certificate must be issued to the aim that potential owners or tenants are able to compare and asses the energy performance of buildings. The energy performance needs to be calculated according to a methodology that is in accordance with the common general framework provided by the European Commission. The certificate must also include recommendations for cost-effective improvements to the building. The certificate is valid for a maximum of ten years. In buildings where a minimum floor area of 1,000 m^2 is occupied by public authorities or other institutions providing public services, the energy performance certificate needs to be made clearly visible to the public in a prominent place.

EPBD recast 2010: tightening of requirements and the introduction of a control system
The recast of the directive in 2010 extends the existing obligation to display the certificate in buildings with a minimum floor area of 500 m^2 in 2012 and 250 m^2 in 2015 to increase awareness and provide an incentive for owners to take energy saving measures. Also, commercial buildings with this minimum floor area that are often visited by the public are now required to display the certificate in case there is one. Furthermore, the leading role of the public sector has been enhanced by getting Member States to stimulate public authorities to implement the recommendations that are provided with the certificate within its validity period. Also, the certificate must include where to find additional information on the included recommendations and the energy performance indicator must be included in advertisements for buildings in commercial media. An independent control system needs to be put in place to check and enforce compliance regarding the issuance of certificates by qualified and accredited experts.

Objective of the EPBD
The original objective of the EPBD is to reduce the energy consumption of buildings by 20% in 2020 compared to the level in 1990. The role of the system of certification and the display thereof in buildings frequently visited by the public is to provide information about and generate awareness of the energy performance of buildings, to give recommendations on cost-efficient measures that may improve the energy efficiency and to create transparency for the non-residential property market. Combined with information campaigns, the EPBD aims to encourage owners and tenants to invest in the energy efficiency of their buildings. The underlying assumption is that, when building owners have information on cost-optimal improvements, they will take these measures. The system can also be used as a policy tool for the design and implementation of financial instruments (chapter five) and to compare standards at an international level.

2.1.1 In what areas does the directive provide member states with room for discretion?

The directive leaves room for member states to differentiate the methodology for calculating the energy performance of buildings on a national or regional level, for new and existing buildings and for different types of buildings with different functions (e.g. homes, offices, educational buildings, hospitals). The provided general framework outlines the characteristics of buildings that should be included in the calculations, such as heating and air-conditioning systems and built-in lighting, and also aspects that positively influence the energy performance of buildings, like solar panels. In this way member states have room to implement a calculation method that suits the local circumstances, such as building tradition and climate. In 2010 it was made explicit that for single-family houses an assessment may be based on a representative building of similar design, size and energy performance when this can be guaranteed by experts. Also, member states have discretion in the quality control system that they should set up and they may delegate these responsibilities.

2.2 How is the directive implemented into national legislation in the Netherlands?

Energy index as the basis for EPC calculations
The Netherlands have chosen to comply with the EPBD by building upon the system of the Energy Index that was already in place since 1995. The implementation of the EPBD into national legislation in the Netherlands followed the timeline in figure 2.1. However, this only considers existing buildings. For new buildings, an energy performance coefficient has to be calculated, based on a different method which takes new features of buildings into account (see chapter 3 for more detail). From 2008 the certification of existing buildings and the display of the certificate for buildings used by public authorities of at least 1,000 m^2 has been in force as part of the 'Decree on Energy Performance of Buildings' (Besluit Energieprestatie Gebouwen (BEG)) and the 'Regulation on Energy Performance of Buildings' (Regeling Energieprestatie Gebouwen (REG)).

Regarding the certificate, the Netherlands have initially chosen for a system in which a qualified assessor visits the building and based on the quality of construction and installations calculates an Energy Index with accredited software (on a scale of about 0 to 4, an expert EPC). For houses, the energy index compares the performance to an average Dutch house built in 1990 (EI = 1). The costs of getting an Energy Index are about € 150 - € 200 for residences and € 700 - € 800 for non-residential buildings (often depending on the size). For housing corporations providing social housing, the Energy Index is often calculated for complexes of similar houses which lowers the costs (€ 100 per house).

EPC ignored in the early stages of the EPBD, introduction of simplified label
In practice, the obligation to present an energy performance certificate at the moment of transaction was often bypassed by sellers and buyers of privately-owned homes by signing an agreement that states that an EPC is not available. Because there was no control or sanctioning system in place that enforced compliance, they could save on the costs of the EPC. This led to insufficiently low levels of energy performance certificates in the residential sector and as a consequence (among other reasons) the EU started a 4th infringement procedure against the Netherlands.

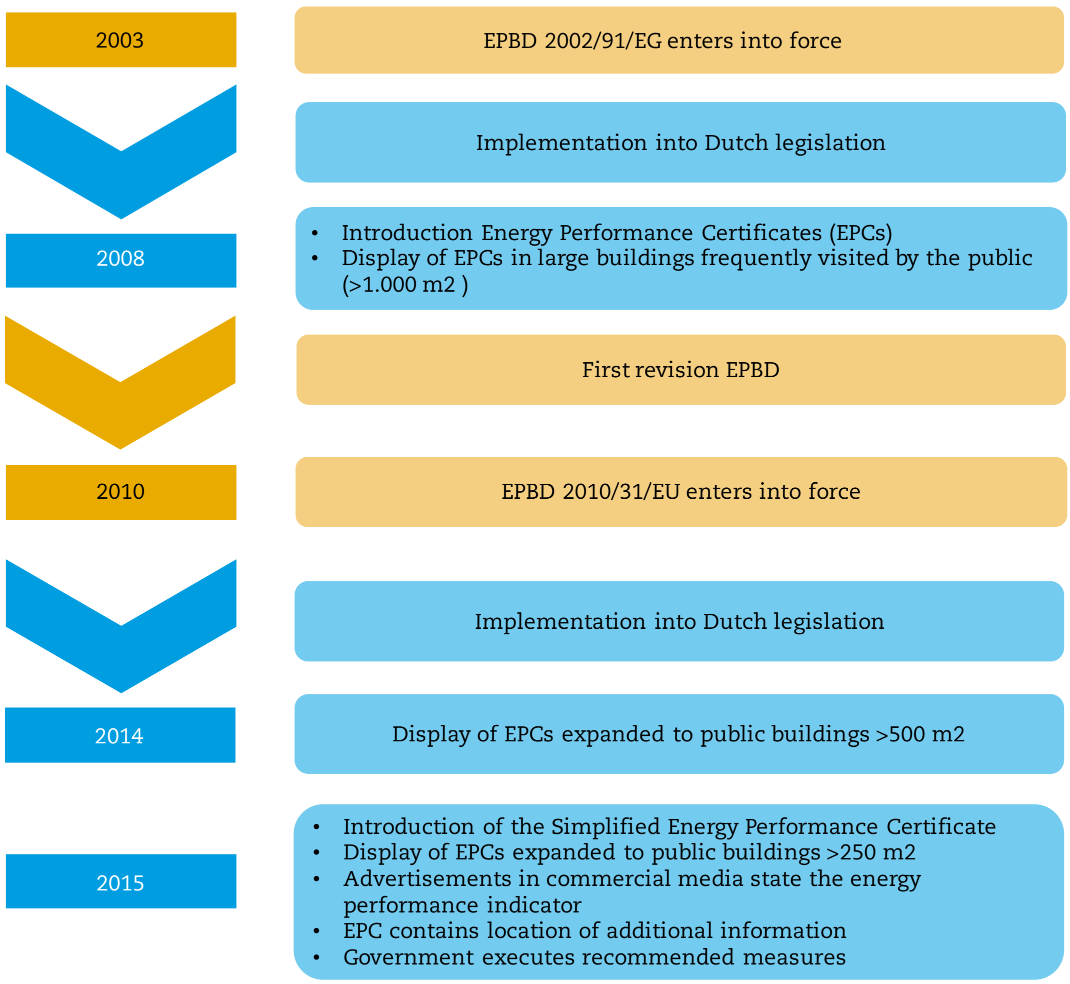
To adhere to EPBD guidelines and to limit the costs of the obligation, in 2015 a simplified energy label (Vereenvoudigd Energie Label (VEL)) was introduced. This system is based on typical Dutch building standards through time and takes 10 characteristics and/or improvements of the house into account that influence the energy performance. Homeowners can apply for the energy label online after which they get an independent expert to check the details online and sign off the label in the online database that has been put in place. The costs for the simplified label are about € 10 on average[75]. With the introduction of the simplified label, it was obligated to present a label for both existing and newly built houses. This was different than before, as

[75] The costs range from € 1 to about € 30, in the report "Energielabel voor koopwoningen" the Dutch audit office (Rekenkamer) finds an average of € 8,80. Therefore, using an average of € 10 seems reasonable.

new houses only needed to present an energy performance coefficient (see chapter 3). This addition was therefore not prescribed by the EPBD.

The Dutch legislation on energy performance certificates does not specify the use of either a simplified label or an expert EPC for different type of home owners (privately owned homes, commercial homes or social housing). Additional regulations for social housing corporations prescribes the use of expert EPCs for social housing[76]. For private rental property, however, such an agreement is not made. Therefore, given the large price difference between expert and simplified labels, one can assume that for all private rental housing a simplified energy label is used.

Figure 2.1 Implementation of the EPBD regarding the energy performance certificate in national legislation in the Netherlands



Source: EIB

Since 2015 the term 'energy label' is used for both the simplified label and the energy performance certificate[77]. The energy label ranges from A to G, where buildings with label A

[76] The 'woningwaarderingsstelsel', which is used for determining rents, demands an Energy Index, which can only be provided by an expert and is not part of the simplified label.

[77] In the rest of the chapter the system of energy performance certificates refers to both the expert EPCs for social housing and non-residential buildings as well as the simplified energy labels for privately owned homes.

have a lower energy index and thus a better energy performance than buildings with label G (table 2.1). Other requirements concerning the content and use of the energy performance certificate, such as the display in buildings with a total floor area of at least 250 m^2 and visited by the public, have all been implemented in 2015.

Table 2.1 Energy index by energy performance indicator/label for residences

Energy performance indicator/simplified energy label	Energy Index
A	≤ 1.20
B	1.21 – 1.40
C	1.41 – 1.80
D	1.81 – 2.10
E	2.11 – 2.40
F	2.41 – 2.70
G	≥ 2.71

Source: RVO

Non-residential buildings use expert EPCs
For non-residential buildings the expert EPC is still in use which calculates the Energy Index. These categories of buildings did comply with the 2008 legislation regarding energy performance certificates.

2.2.1 What control system is in place?

Enforcement: energy labels monitored and fines for non-compliance
In the Netherlands the control system concerning the energy labels was delegated to the Human Environment and Transport Inspectorate (Inspectie Leefomgeving & Transport (ILT)). They monitor the availability of energy labels at the moment of selling or renting out to new tenants and oversee the display of energy labels in buildings in use by public authorities or frequently visited by the public. In case no energy label is provided, the Inspectorate is able to fine the selling party or home owner. This fine depends on whether it concerns a residential home (€ 170) or a non-residential building (€ 340).

Certification of companies: guidelines to issue EPC
Companies provide simplified energy labels for private houses or expert EPCs for rental housing or non-residential buildings. To be able to issue these, they need to have the NL-EPBD certificate. To obtain this certificate the companies need to meet a list of requirements, such as having a written quality guideline, an internal control system, an enlistment at the Dutch Chamber of Commerce and a contract with at least one qualified energy performance advisor. The certification of the company includes yearly inspection by the certifying institution of the company's policies and a quality control of the issued labels and EPCs. In case of non-compliance to any of requirements, measures may be taken which include suspension of the certificate. However, from the expert interviews follows that to this date (hardly) any companies have lost their certification.

Besides the certification of the company, the advisors in service of the company must meet certain requirements, of which an exam and a course day at the Netherlands Enterprise Agency (RVO) about the database comprise an important part. These exams are different for houses and non-residential buildings and new and existing buildings. Occasionally, advisors have to take refresher courses to stay up to date with legislation and building practice and to improve the quality of the energy labels. The courses for the advisors are certified by InstallQ.

2.2.2 Expected regulatory burden of implementation and alternatives considered

Cost efficient initial implementation
Regulatory burden has played an important role at the implementation of the additional requirements of the EPBD of 2010 in the Netherlands concerning EPCs. As the current system has been built up in several stages, there have been different studies that have looked at the regulatory burden from different policy options that were considered in the implementation process (table 2.2)[78]. In general, it can be concluded that the Netherlands have implemented the extra requirements from the EPBD of 2010 regarding energy performance certificates at relatively low cost, choosing least costly alternatives when possible. The reviewed studies in this chapter only looked at the additional measures from the EPBD 2010 concerning EPCs (energy labeling). This means the costs of the expert EPC itself, the needed time investments and the enforcement system are not included in these studies as these were already in place after the implementation of the EPBD of 2002. The regulatory burden as a consequence of the original setup in 1995 has been left out of scope in this research.

Alternatives considered lead to higher burden and were generally disregarded
For the display of EPCs in public buildings it has been considered whether to include education and health care buildings. The initial costs for this have been estimated at € 420,000 and the alternative has not been implemented. The requirement to include the energy performance in advertisements of buildings in all cases is the only option chosen with larger regulatory burden than the alternative (only for buildings that have a rating). The EPBD prescribes that the EPC must be included in advertisements, so the less costly option would not meet the requirements of the directive.

For some measures, such as the inclusion of EPCs in advertisements, the development and maintenance of a list of cost-efficient measures and a method for the calculation of the energy performance and a registration system of energy labels, only the costs are presented. It is unknown whether alternatives were considered; alternatives were not part of the studies reviewed.

Implementation of the simplified energy label: a reduction of costs
Table 2.3 gives an overview of the initial and yearly costs from the new system of simplified energy labels and a comparison with the structural costs before implementation of the simplified energy label for residential buildings in 2015[79]. The initial costs from the introduction of the simplified system were estimated around € 0.8 million, while the yearly costs amount to approximately € 12 million. The costs for the labels are expected to be between € 20 to € 40 (three scenarios are projected in the study; the average scenario is presented here).

The reduction in the yearly costs is expected to be between € 12.6 to € 15.6 million in comparison with the previous system of expert EPCs (which was estimated around € 26.2 million a year). The administrative burden for the government and delegated organizations is not included in this study.

[78] Some other effects from the implementation of the system are included in the study “Onderzoek naar de gevolgen van de EPBD recast voor Nederland” (2009) PRC. However, as the results of this study cannot be traced back and do not coincide with the results from “Gevolgen administratieve en uitvoeringslasten herziene EPBD” (2010) Sira Consulting, these are not presented here.

[79] SIRA Consulting (2014), Regeldrukeffecten vernieuwd energielabel voor woningen. From the different scenarios that have been calculated, the average is taken.

Table 2.2 Overview of policy options that have been considered and the involved regulatory burden for different parties

Implemented requirements	Initial costs	Yearly costs	Type costs/owner	Enforcement costs
– Development and maintenance of list of cost-efficient measures to be included in the label[2]		€ 450,000	Government implementation costs	
– Registration system energy labels[2]		€ 75,000	Government implementation costs	
– Development and maintenance of calculation method energy performance[2]		€ 450,000	Only part of the costs are a consequence of the EPBD	
– Knowledge development new regulation and display label in commercial buildings[1]	€ 20.8 million		€ 10.2 million commercial companies, € 10.6 million owners of commercial buildings required to display the label	€ 68,000[2]
– Include energy performance in advertisements for all buildings[1]		€ 1.4 million	Selling building owners (private or commercial)	
Total additional costs	**€ 20,8 million**	**€ 2,4 million**		**€ 68,000**
Other options considered				
– Include health and education buildings in buildings that are required to display the EPC[1]	€ 420,000		Government implementation costs	
– Include energy performance in advertisement of buildings if a rating is available[1]		€ 330,000	Selling building owners (private or commercial	

1 From 'Gevolgen administratieve en uitvoeringslasten herziene EPBDr' (2010) Sira Consulting.
2 From 'Onderzoek naar de gevolgen van de EPBD recast voor Nederland' (2009) PRC.

Source: SIRA Consulting, PRC edited by EIB

Table 2.3 Overview of the expected initial and yearly regulatory burden from the system of simplified energy labels for households and businesses

Frequency	Party	Requirement	Old system	New system
Initial	Businesses	– Obtain necessary qualification		€ 38,000
		– Knowledge development new system		€ 717,000
Total initial costs				**€ 755,000**
Yearly	Businesses	Obtaining energy label	€ 11,822,000	€ 7,292,000
	Issuing companies	– Qualification experts		€ 856,000
		– Enforcement		€ 165,000
	Households	Obtaining energy label	€ 14,385,000	€ 3,769,000
		Enforcement		€ 51,000
Total yearly costs			**€ 26,207,000**	**€ 12,133,000**

Source: SIRA consulting, edited by EIB

Conclusions on the expected regulatory burden
In general, it can be concluded that the available studies have mostly provided a projection of the administrative burden for citizens and businesses and, in some cases, the implementation and enforcement costs for the government (organizations). However, given that the system was built up in stages, none of the performed studies have provided a complete overview of the total costs of the system, which complicates a comparison with actual regulatory burden (paragraph 2.3.1 will provide a comparison of expected and actual regulatory burden for the areas where this is possible). Finally, the studies only present the costs of the different policy options without showing potential benefits from the systems. This may lead to suboptimal policy making when there are more costly policy options that have larger benefits. In that case the least costly system may be implemented, while from the perspective of proportionality of costs and benefits another system may be preferred.

2.3 Regulatory burden and benefits in practice

2.3.1 Regulatory burden: expected versus actual

Paragraph 2.2 presented the expected regulatory costs from parts of the EPBD recast and some of the alternatives that have been considered. As indicated before, the studies focus on the effects of individual measures and the exact implementation was not always decided at the time of the research. Appendix B presents an overview of the entire regulatory burden in practice as a result of the EPC requirements which stem from the EPBD.

Table 2.4 presents the actual versus expected regulatory burden. This has been done for those costs that were calculated ex ante and can be reproduced for the actual costs. Some initial costs presented in the appendix were not included in earlier studies, which makes comparison impossible. There are several reasons for this. Firstly, the instruction for the initial studies was to calculate the regulatory burden for households and businesses only, which leaves out the (sometimes) large costs for the government. For example, the initial costs from the development of the webtool for simplified energy labels and the accompanied training were not included. However, also the costs related to the obligatory webtool training for energy experts and EPC experts were not included in the calculations. Also, the training and examination of

EPC experts was not calculated in light of the EPBD recast of 2010 as this system was already in place.

Initial costs
The estimation of the initial costs resulting from the additional requirements of the EPBD of 2010 were estimated at € 20.8 million. These are made up of costs related to time invested by building owners to become familiar with new legislation, referred to as knowledge development costs (€ 10.2 million), and the display of the label in commercial buildings (€ 10.6 million). Our estimation totals to about the same (€ 20.7 million). However, we estimate the costs for knowledge development to be slightly lower, while costs related to the display of the label in buildings turned out higher in practice. Firstly, the calculations around the knowledge development were based on 451,000 non-residential building owners having to update their knowledge of the implementation of the new requirements. However, in practice some building owners are in possession of entire portfolios of properties, which leads to a large reduction in the regulatory burden. We have assumed instead, that on average every owner owns 1.5 buildings and so 317,000 professionals need to update their knowledge which reduces the burden by about 30% to approximately € 7.2 million.

In addition, the display of the label in commercial buildings was presented as an initial cost for 238,000 commercial buildings that are larger than 500 m^2 and are regularly visited by the public. It was assumed that this takes one hour on average, which results in a cost of € 10.6 million. In this study, however, we classify these costs as a structural cost that (re)occurs every time a (new) label is issued, at least once every ten years. The label only has to be displayed if it is available. Also, at the time of the study it was already known that the requirement to display the label would be extended in 2015 to include non-residential buildings larger than 250 m^2 that are frequently visited by the public. We have estimated this comprises 300,000 buildings[80]. When we estimate these costs as initial costs in a similar way to previous calculations, to be able to compare results with previous studies, this would result in costs of € 13.5 million. This is nearly € 3 million more than estimated.

[80] As a consequence, we estimate the number of buildings frequently visited by the public and between 250 m^2 and 500 m^2 in size at 62,000.

Table 2.4 Comparison of the expected and actual regulatory burden from the system of energy performance certificates in the Netherlands

Frequency	Party	Requirement	Expected/ actual	Amount	Time investment (hours)	Hourly rate	Costs time-investment	Costs (each)	Total fees	Total costs
Initial	Businesses	Knowledge development	Expected	451,000	0.5	€ 45	€ 10,200,000			**€ 10,200,000**
			Actual	317,000	0.5	€ 45	€ 7,169,401			**€ 7,169,401**
		Display label commercial buildings	Expected	238,000	1	€ 45	€ 10,600,000			**€ 10,600,000**
			Actual[1]	300,000	1	€ 45	€ 13,500,000			**€ 13,500,000**
Total expected										**€ 20,800,000**
Total actual										**€ 20,669,401**
Yearly	Private home owners	Simplified energy labels	Expected	67,000	1-2	€ 15	€ 1,800,000	€ 30	€ 2,000,000	**€ 3,800,000**
			Actual	131,250	2	€ 15	€ 3,937,500	€ 10	€ 1,312,500	**€ 5,250,000**
	Commercial home owners	Simplified energy labels rental properties	Expected	51,500	1-2	€ 45	€ 3,592,125	€ 30	€ 1.545,000	**€ 5,137,125**
			Actual	96,000	2	€ 45	€ 8,640,000	€ 10	€ 960,000	**€ 9,600,000**
	Developing companies	Simplified energy labels newly built houses	Expected	21,500	1-2	€ 45	€ 1,499,625	€ 30	€ 645,000	**€ 2,144,625**
			Actual	80,000	0.5	€ 45	€ 1,800,000	€ 5	€ 400,000	**€ 2,200,000**
Total expected										**€ 11,081,750**
Total actual										**€ 17,050,000**

1 The display of the label had been marked as initial costs. For consistency reasons we have kept these costs as initial. However, the costs presented reoccur every 10 years.

Source: EIB

Structural costs
Structural costs turned out 55% higher than expected beforehand. The largest recurring costs are the costs for the simplified energy labels and EPCs. In our perspective the regulatory burden from the simplified energy labels is higher than was projected in 2014, especially for private home owners and commercial home owners. The yearly costs for homeowners were estimated at € 3.8 million in the average scenario. This was based on an estimate of 67,000 houses being sold by private home owners in 2013 for which no energy label or EPC was available (80% all private properties sold). Costs of the label were estimated at € 30 on average and owners were expected to spend around 1.75 hour on providing the right information. In practice, however, the amount of transactions has been a lot higher than in 2013 as the amount of transactions that year was at the lowest point in the past 25 years (total around 110,000). Our calculations are based on 175,000 transactions of existing houses a year, which is approximately the average over the past 10-20 years. As 75% is sold by private owners, this amounts to around 130,000 transactions for which a label is required. As hardly any private home owners had purchased an EPC before the implementation of the simplified labels, it is assumed that for all transactions a new label is required. The costs of the labels turned out lower in practice, about € 10 instead of € 30 and owners spent approximately 2 hours on providing all the information. This results in a total cost of around € 5 million a year, roughly 40% higher than initially expected.

In a similar way, the costs for commercial home owners renting out residential buildings is higher than estimated. Before the introduction of the simplified labels, the yearly costs were estimated at € 5.1 million, based on 51,500 transactions, the same costs per label as for households (€ 30) and approximately 1.5 hour per label. However, we estimate these costs at € 9.6 million considering that a label is required for all houses that are commercially rented, on average around 960,000 between 2010 and 2019[81]. It is assumed that every year a tenth of these need a new label at a cost of € 10 and commercial building owners spend on average 2 hours on each label (given that they need to organize getting access to the property).

The regulatory burden resulting from the requirement that a label is needed at the delivery of newly built houses is approximately the same as was estimated initially, even though the inputs of the calculations are very different before and after implementation of the simplified labels. In 2014 the costs were project to be € 2.1 million, based on 21,500 new houses for which businesses need to obtain a label. It is not clear what this number of new houses is based on. Our calculation relies on the delivery of on average 80,000 new houses a year (newly built and transformation of buildings[82]). Businesses that deliver new buildings are expected to spend on average half an hour per house and the price of the label is down to € 5 (as they often build similar type houses). This leads to a cost of € 2.2 million a year.

Comparison actual burden and table 2.2
The costs of expert EPCs for social housing and non-residential buildings were not included in the studies before the implementation of the EPBD of 2010 as these were already introduced at the implementation of the EPBD 2002. However, there are some other areas in which the actual costs turn out differently than projected. It was estimated that the inclusion of the energy performance in advertisements for buildings would amount to € 1.4 million on a yearly basis. It is not motivated what this is based on but given the expert interviews, it seems that this did not turn out so costly in practice as it only required a change of the advertisement system and hardly leads to additional costs when advertisements are created.

The development and maintenance of the list of cost-efficient measures to be included in the energy label, development of the calculation method to determine energy performance and the registration system for energy labels were part of the general activities of RVO and could not be traced back. There are no indications, however, that the estimation of € 450,000 and € 75,000 (table 2.3) respectively seems unreasonable given the actual implementation.

[81] CBS, Voorraad woningen; standen en mutaties vanaf 1921.

[82] CBS, Voorraad woningen; standen en mutaties vanaf 1921.

Requirement to present an EPC for new houses leads to an increase in regulatory burden
With the introduction of the simplified label, newly built homes were also required to obtain an EPC. As the EPBD states that for newly built homes an EPC is not necessary for the first 10 years, this can be seen as an unnecessary increase of regulatory burden. This choice results in additional yearly costs of about € 2.4 million (appendix B).

Estimation of regulatory burden generally reasonable, some room for improvements
In general, the projections of the regulatory burden were reasonable. However, there are three lessons to be learned. Firstly, it is important to base the calculations on long-term averages to prevent the estimates to be affected by conjunctural developments. The estimation of the burden from the system of simplified energy labels for private home owners and businesses was based on the amount of transactions in 2013, which was the lowest amount of transactions in the past 20 years. As it could not reasonably be expected that the amount of transactions would remain that low in light of the crisis and the number of transactions before the crisis, the calculations would provide a more realistic perspective of the costs if long-term averages were used as an input.

Secondly, the assumptions that are made in the process should align with actual practice. There were several instances where the assumptions were too straightforward. For example, it was assumed that there are around 450,000 non-residential buildings owners, based on the amount of non-residential buildings. However, this is not reasonable in light of how many buildings are part of portfolios owned by investors. Also, the requirement to provide a label in case of (new) tenants of rental properties was not included in the calculations. Only transactions of these properties were included in the calculations, while this does not provide a complete picture on the regulatory burden of the implementation of the EPBD in case of full compliance. Better quality control and involvement of experts in the process of assessing regulatory burden are important to ensure the right assumptions are applied.

Finally, when temporary requirements are introduced that build towards a more tight requirement, for example in the case of the requirement to display the label in buildings larger than 500 m^2 in 2012 and 250 m^2 in 2015, it is important that both the temporary and the final requirement are included in the calculations of the regulatory burden to provide a complete overview of the costs.

2.3.2 Benefits from the system of energy performance certificates

The aim of the system of energy performance certificates was to increase awareness among building owners in order to reduce energy demand of buildings. However, the potential effect of energy labels on energy savings depends on two factors. Firstly, it is important to know whether the information on the energy label (and EPCs) and the recommendations on the energy efficiency of the building actually leads to increased awareness among building owners and if more cost-efficient measures are taken to improve its performance as a consequence of EPCs. Secondly, buildings that are relatively more energy efficient (and therefore have a better label) should be valued at a higher price than less energy efficient buildings. Houses with a better energy performance have a lower energy bill and are more comfortable. Therefore, buyers of houses are willing to pay a premium for houses with a better energy performance. This might also stimulate owners to invest in energy saving measures. These two factors are discussed separately below.

Small positive effects of energy labels on energy saving cannot be ruled out
The EPBD is founded on the underlying assumption that buyers and sellers were in need of additional information on the energy performance of buildings. It was also assumed that building owners would invest in cost-efficient measures to improve the energy efficiency if provided with recommendations on how to do so. In general, from expert interviews and

several studies[83] in the Netherlands it can be concluded that energy labels have increased the awareness among private home owners on the energy performance of their homes over time.

One study based on surveys concludes a weak influence of EPCs on decision making[84]. Another study based on surveys[85] states that 'the energy label has a positive effect on awareness' and mentions that '10% of the people who took energy saving measures would not have done this without the energy label'. On the other hand, a larger share of non-recipients (not in possession of an EPC) than of recipients (in possession of an EPC) have invested in the energy performance of their home (respectively 31% and 25%)[86]. Furthermore, non-recipients were more likely to spend more or plan on taking energy saving measures in the future than recipients. In many cases the recommendations were ignored[87] and measures would also have been taken without the availability of a label[88]. Weighing the different viewpoints, it can be concluded that a small effect of energy labels on energy saving cannot be ruled out.

Low costs of labels have contributed to a higher compliance rate than before the introduction of simplified labels. If the higher compliance rate leads to higher awareness (which is a safe assumption, as more home owners have received energy labels), the lower costs likely have contributed to higher awareness.

Effect on housing prices is a consequence of energy performance, not of the label
The studies presented above suggest that the energy label might have a small effect on investments in energy saving measures. Some studies conclude an influence of EPCs on prices[89] (not attributable to energy savings) and an influence on time on the market[90]. In order to assess these studies, it has to be established whether these influences are the sole result of the energy label or that other factors are responsible for these premiums, so called composition effects. Based on the methodology of aforementioned studies, composition effects cannot be ruled out. CPB[91] has recently analyzed price premiums and concludes that 'a better label does not associate with a price premium at the margin (between energy labels). While energy efficiency is well-capitalized, energy labels do not seem to provide additional information that is not already priced in the market'. A number of other studies confirm that there is no evidence that a better energy rating results in a price premium that is *not* related to the energy savings of better EPCs [92] [93]. This lack of an 'additional' price premium is confirmed by our expert interviews.

Olaussen, Oust and Solstad (2017)[94] find that the price premium in Norway for more energy efficient houses is related to the better performance of the building itself, and not to the energy label. By comparing the prices of houses before (2010) and after the introduction of energy labels (2014), they found that there had already been a price premium before energy labels were

[83] Murphy, L. (2014), The influence of energy audits on the energy efficiency investments of private owner-occupied households in the Netherlands, Energy Policy 63 398-407. Algemene Rekenkamer (2016), Energielabel voor koopwoningen. Kantar Public (2017), Onderzoek energielabel voor woningen.

[84] Murphy, L. (2014), The influence of energy audits on the energy efficiency investments of private owner-occupied households in the Netherlands, Energy Policy 63 398-407.

[85] Kantar (2017), Onderzoek effect energielabel voor woningen.

[86] Kantar Public (2017), Onderzoek energielabel voor woningen.

[87] Murphy, L. (2014), The influence of energy audits on the energy efficiency investments of private owner-occupied households in the Netherlands, Energy Policy 63 398-407.

[88] Kantar Public (2017), Onderzoek energielabel voor woningen.

[89] Brounen, D., Kok, N. (2011), On the economics of energy labels in the housing market, Journal of Environmental Economics and Management.

[90] Aydin, E., Correa, S.B., Brounen, D. (2019), Energy performance certification and time on the market, Journal of Environmental Economics and Management.

[91] CPB (2020), The information value of energy labels: Evidence from the Dutch residential housing market.

[92] Jessica Havlínová en Dorinth van Dijk (2019), Verplichte energielabels hebben positief effect op verduurzaming van huizen, ESB, 12 september, 2019, https://esb.nu/esb/20055699/verplichte-energielabels-hebben-positief-effect-op-verduurzaming-van-huizen.

[93] PBL (2020), Woonlastenneutraal koopwoningen verduurzamen. The study mentions 'different studies on the effect of energy labels on value, show a fairly consistent result of limited value effects'.

[94] Olaussen, Oust and Solstad (2017), Energy Performance Certificates – Informing the Informed or the indifferent?, Energy Policy (2017), vol 111, p.246-254.

introduced. They conclude that the price premium generally attributed to the energy label must be correlated with omitted variables, such as the energy performance itself or building aesthetics.

For non-residential buildings, no studies have been found that research the effects of energy labels on investments in energy efficiency. However, the fact that additional minimum standards are set for offices (minimum rating C by 2023) and that requirements are set for other non-residential buildings to stimulate investment in cost-efficient measures, suggests that energy labels and recommendations on cost-efficient investments itself have not brought about satisfactory levels of investments. This is confirmed by interviews with experts in light of this study.

In the conducted interviews, other reasons are given for investments in energy saving: comfort and financial triggers are named as the primary reasons. In order to increase the effects of the EPCs on energy savings, multiple countries are evaluating the design of the EPC as the current designs do not lead to satisfactory results[95]. The importance of financial triggers is confirmed in the aforementioned study by Kantar ('only few people state that the energy label is the reason for taking energy saving measures and that financial consequences play a much more important role'). Some financial institutions use EPCs to determine the maximum mortgage and give discounts on interest rates for better EPCs. If these favorable conditions are meaningful and have an effect, they would lead to a higher demand for buildings with better EPCs, raising the prices of these properties and as such a price premium would be observable. As shown, this price premium is not present yet, although some effect of favorable conditions cannot be excluded in the future, dependent on the design. As financial triggers are the primary reason for investing in energy saving measures and as better EPCs currently yield no price premium, the effect on behavior seems limited in practice. From this point of view, the choice for simplified energy labels for residential buildings seems balanced.

2.4 What are the experiences with the legislation in practice?

In practice, the system of energy performance certificates that was in place before 2015 did not work well for residential home owners as it was expensive and there was no control system in place. The new system of simplified energy labels and the concurrent control system were introduced under pressure of the organization that advocates for the interest of private home owners and the parliament. As a consequence, the costs for private home owners have significantly dropped and compliance has improved drastically. While the compliance rate amongst private home owners had been very low before the introduction of simplified labels, the Inspectorate claims that nowadays 92% of homes sold each year do have an energy label, excluding 2% of 'non-sales' for which no label is needed (e.g. in case of divorce and sale to one of the partners).

The different systems currently in place for new and existing buildings, cause extra regulatory burden as in some cases both energy indicators are needed for the same building. For all new buildings the energy performance coefficient (EPC) is required to obtain a building permit (see chapter 3). Initially, for most buildings no energy performance certificate was required during the first ten years as it is assumed all buildings are constructed in accordance with the cost-efficient minimum standards. However, due to other legislation, owners of newly built social housing and buildings in use by public authorities are required to obtain an Energy Index for existing buildings as well. With respect to social housing this stems from the obligation to present the certificate to (potential) tenants and the Energy Index is also needed to determine the rent. For owners of public buildings this relates to the requirement of displaying the energy label in a prominent place.

Other factors that determine the regulatory burden resulting from the existing system are the limited validity of EPCs (energy labels) and the requirement to implement cost-efficient

[95] Portugal and Germany, for instance, are discussing including comfort in the EPC system, as the current design does not incentivize people enough to take energy saving measures. The belief is that by stressing the increase in comfort, for instance when applying insulation, more measures will be taken than when the focus lies on energy (saving).

recommendations for public buildings within the validity period of the EPC. Commercial or social housing organizations have to renew the energy performance certificate when its validity expires (after ten years), even when the energy performance of the house and the tenants have not changed. Therefore, costs have to be made to obtain the exact same EPC. Also, the requirement for public authorities to implement the cost-efficient recommendations contained in the certificate within its validity period does not always coincide with natural renovation cycles (about every 30 years). As a consequence, additional renovations need to be done, or planned renovations have to be accelerated, which increases the total costs.

2.5 Implementation of the amendments of the EPBD of 2018

The amendments of the directive of 2018 prescribe that the energy performance of buildings must be based on the primary energy demand of buildings and must be expressed in kWh/m^2/year.

Expert EPCs reintroduced from 2021 in the Netherlands
In order to comply with this requirement, the Netherlands have developed a calculation method, the NTA 8800, which can be applied to both new and existing buildings and residential and non-residential buildings. For new houses the calculation of the energy performance is included in the building permit process and includes many characteristics of the house. For existing houses, on the other hand, the number of characteristics is much lower as not all information is available. More information may be added if this leads to an improved energy rating. As the calculation method is more sensitive to the geometry of the building and many other characteristics are needed to determine the energy performance, the Dutch government has decided that only an expert can provide the EPC based on an on-site visit. This implies that the current system of simplified energy labels will be discontinued.

Underestimation of regulatory burden from the new considered EPC system
The Dutch government has requested a study to provide insight into the effects of the new system on regulatory burden. In the study[96], it is concluded that the additional costs from such a new system would initially be around € 3 million and on a yearly basis nearly € 20 million (table 2.5), of which approximately half accrues to private home owners and half to commercial home owners.

Table 2.5 Projections of additional costs from a system of expert EPCs compared to the existing system of simplified energy labels

Frequency	Party	Requirement	Additional costs compared to existing system
Initial	Energy experts	Course and examination	€ 579,200
	EPC experts	Update course	€ 2,635,200
Total initial costs			**€ 3,214,400**
Structural	Private home owners	Expert EPC	€ 9,339,800
	Companies	Expert EPC	€ 10,176,200
Total structural costs			**€ 19,516,000**

Source: SIRA Consulting

[96] SIRA Consulting (2019), Lastenmeting wijziging energieprestatiemethode en inijking energielabel.

In order to compare the costs of the different systems, it is important to keep the amount of energy labels constant. However, just as with the study described in paragraph 2.3.1, the costs in table 2.5 are estimated based on transaction data from 2013, the lowest amount of transactions in years[97]. Also, the calculations are based on the statistic that 34% of the residential transactions are apartments, for which the costs of the expert EPC are lower than for other houses as they are on average smaller. Though this 34% is based on the share of apartments in the housing stock, the share of apartments in the total amount of transactions would have been a more accurate approximation of the actual share of apartments in the total transactions, which is 28% (CBS, see last footnote). Both these aspects of the calculation lead to an underestimation of the actual difference in the regulatory burden between both systems (as expert EPCs are generally cheaper for apartments than for single-family homes). Instead, the calculations from 2014 could have been corrected with the most recent insights to give a more realistic projection of the difference in the regulatory burden between the two different systems.

Table 2.6 provides a projection of the increase in the yearly regulatory burden as a consequence of the reintroduction of the expert EPC for residential buildings, based on the long-term average of transactions and the average share of apartments. As a consequence, the costs are estimated at € 33 million, instead of nearly € 20 million. Costs for private home owners increase by about € 19 million, instead of € 9 million, while for commercial building owners it increases by € 14 million, instead of € 12 million. Similar to the underlying calculations of table 2.5, it has been assumed that the additional costs of the expert EPC for single-family homes is € 170 and € 80 for apartments compared to a simplified energy label. The same share of apartments is used for the transactions of private home owners and commercial building owners. The costs for commercial home owners are not based on the amount of yearly transactions, as in table 2.5, but on a tenth of the total stock for which a new EPC must be issued each year. If every privately and commercially owned home (approximately 4.8 million dwellings) would need to obtain an expert energy label[98] at an additional cost of € 150 per home compared to simplified labels, this would mean an additional cost of € 720 million.

Table 2.6 Projections of additional costs from a system of expert EPCs compared to the existing system of simplified energy labels, based on more recent transaction data

Party	Type property	Amount	Additional costs per one	Total costs
Private home owners	Single-family homes	94,500	€ 170	€ 16,065,000
	Apartments	36,750	€ 80	€ 2,940,000
Total private home owners		**131,250**		**€ 19,005,000**
Commercial home owners	Single-family homes	69,120	€ 170	€ 11,750,400
	Apartments	26,880	€ 80	€ 2,150,400
Total commercial home owners				**€ 13,900,800**
Total home owners				**€ 32,905,800**

Source: EIB

[97] CBS https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83910NED/table?ts=1591798508973

[98] The social housing stock uses on-site expert EPCs as the maximum rent is partly based on expert EPCs.

No projections were made on the increase or decrease of regulatory burden as a consequence of a different time investment that is required in order to obtain an expert EPC. Also, the cost reduction resulting from the expiry of the requirement to issue a simplified label for newly built houses is not included here (as both of these are not included in SIRA (2019) and comparison must be performed on the same basis). Despite this, the costs from reintroducing a system of expert EPCs for all buildings seem underestimated. As stated in paragraph 2.3.2, there are no tangible benefits of an expert EPC compared to a simplified EPC in terms of energy reduction.

Increase in regulatory burden versus accuracy of energy class
The lower regulatory burden of the simplified energy labels has given reason to explore the possibility of basing a simplified label on the new calculation method[99]. The study that was performed to this end concluded that a simplified energy label cannot be based on the new calculation method with at least the same accuracy as the existing system. In short, this is the result of the strong sensitivity of the method to the geometry of the building, while private home owners find it hard to provide the necessary information in practice.

According to DGMR[100], inaccurate measurements of 10% to 20% of the floor surface can lead to deviations of 7% to 15% in energy use. At these inaccurate measurements, about 30% to 40% of the homes would be allocated to the ‘wrong' energy class. These wrongly assigned dwellings will generally deviate one energy class from to the ‘right' measurement. In the old system, based on the Energy Index, about 93% of the dwellings would be rightly assigned despite the aberration. As a result, a simplified label based on the NTA 8800 was deemed too inaccurate compared to the current system and expert EPCs were reinstated[101], as the aim of the study was to explore the possibility of basing a simplified label on the new calculation method "with at least the same accuracy as the existing system".

Reasonable approximation of energy class seems possible without expert visits
The importance of the inaccuracy stems from the observation that home owners are unable to provide accurate information on the geometry of their building. This conclusion is drawn from a study that observed the behavior of eight respondents in providing information for a simplified label, which cannot be seen as representative. Besides this, people do not necessarily need to measure their home themselves: most documentation that is handed over when buying a house contains a floor plan. If people do not have the documentation anymore, a call to the estate agent should be enough to obtain one. Finally, the role of the expert is underestimated in the conclusions of the study. In the current situation, an expert signs off the information that is provided by the home owner and one can assume this situation could be kept in place. The expert will check the information, asks follow-up questions and gives advice on how to deliver proof of insulation or glazing, for instance. Furthermore, the expert could check the dimensions of the building in public databases like the BAG[102]. In the conducted study, it is stated that ‘questions that are initially unknown or complex to people, become recognizable with the help from a professional advisor and can be answered and proven with this help'. These findings indicate that it seems very possible for people to provide the correct information and, with experts signing off the information, mistakes can be minimized. The fact that Norway has a well-functioning simplified label that is also based on kWh/m^2 per year and where geometry is also part of the provided information[103], supports this finding.

Possibility of finetuning online application neglected
The study gave recommendations on the process that was used to test the possibility for private home owners to provide the needed information to calculate the primary energy demand themselves. However, it seems as if these recommendations were not implemented

[99] RVO (2019), Vereenvoudigd Energielabel NTA 8800.

[100] DGMR (2019), Vereenvoudigd Energielabel NTA 8800.

[101] The study of DGMR shows more effects of aberrations, but these are significantly smaller than the one mentioned here. It is important to note that DGMR researched if a simplified label could be based on the NTA8800 with at least the same accuracy as the current simplified label. The answer to this was negative, resulting in the decision to reinstate expert EPCs.

[102] Basisregistraties Adressen en Gebouwen, which contains total square meters of a building, for instance.

[103] See paragraph 2.6.

and an improved online EPC process was never tested. Again, because of the large difference in regulatory burden between simplified energy labels and the expert EPC it seems worthwhile to explore an alternative online EPC process further. One of the recommendations that was never tested was the option to have an EPC expert provide advice through videocalls or other virtual communication options, which could offer a solution for the geometry problem. If testing would be resumed, it is also advised to expand the amount of home owners included in the study in order to get an idea of how well the process works for a representative group of private home owners. Only then a substantiated decision can be made on a system that works well for the majority of the private home owners.

Simplified energy labels could be the appropriate design
From expert interviews, it can be concluded that the experiences with the simplified EPCs in the different countries are generally positive. The general belief is that they provide relatively good and objective information about the energy performance of houses at significantly lower costs. Experts do indicate that the simplified label may be less accurate than EPCs for which an on-site visit is needed. However, in interviews it is stressed that the energy rating may also turn out to be different when on-site visits are used, as experts assess situations differently.

The analysis above leads to the question whether reinstating expert EPCs is desirable. The significant increase in costs has to be compared to the value and benefits of the EPC. As noted, a certain positive effect of EPCs on energy saving investments cannot be ruled out based on conducted studies. However, there is no reason to assume that these effects are significantly larger when using an expert EPC compared to using an online EPC. Currently, there are no policies in effect that use the EPC as a basis[104], which means that a (possible) lack of accuracy does not have large consequences. Furthermore, expert EPCs are not fully accurate either. Considering the above and the significant cost increase, the use of simplified energy labels could well be the appropriate design. If there are concerns about the accuracy of simplified labels, further research can be worthwhile. By taking samples of issued simplified labels and having the same homes visited by, for instance, three experts, the (possibly) different outcomes in practice can be measured. The extent to which the results differ can be analyzed and, based on the differences, the quality of online labels can be improved and the desirability of a possibly more accurate expert EPC can be determined. In order to reduce disputes over assigned labels and to limit the negative effects of inaccurate measurements by home owners when simplified labels are used, a less detailed system may be appropriate. Decreasing the number of categories (for instance from A-G to excellent-good-average-below average) may be beneficial in this case.

2.6 How is the directive implemented in other European countries?

The analysis in the Netherlands shows that the type of energy performance certificate is largely responsible for the regulatory burden of the system for building owners. Table 2.7 gives an overview of the type of certificates that are used in the different countries included in this study and the costs that are involved for both residential and non-residential buildings.

[104] The 'woningwaarderingsstelsel' and RVV uses EPCs, but only expert EPCs are used to this effect.

Table 2.7 Overview of type EPC and prices in other European countries

Sector	Owner	Denmark	England	Germany	Netherlands	Norway	Portugal
Residential	Privately owned	– Online EPC (single family house < 25 years old) € 150 – Expert EPC € 500 – € 700	Expert EPC € 40 - € 70	Expert EPC € 1,000, subsidized to € 40	– Simplified label € 10 – Voluntary expert EPC € 150	– Simplified online label for free – Optional expert EPC € 250	Expert EPC € 250
	Rental	Expert EPC € 500 - € 700	Expert EPC € 40 - € 70	– Expert EPC € 1,000 – Measured consumption EPC € 50 (multi-family homes >5 apartments)	Expert EPC € 100 - € 250	NA	Expert EPC € 250
Non-residential	Commercial	Expert EPC € 1,000	Expert EPC € 150 - € 175	– Expert EPC € 5,000 – Measured consumption EPC € 500	Expert EPC € 800	Expert EPC € 1,000 – 10,000	Expert EPC € 800
	Public	Expert EPC € 1,000	Display Energy Certificate based on measured consumption € 280 yearly	– Expert EPC € 5,000 – Measured consumption EPC € 500	Expert EPC € 800	Expert EPC € 1,000 – 10,000	Expert EPC € 800

Source: Concerted Action, EIB

An extensive description of the system in each of the countries, based on interviews and desk research, is included in the annexes. Below a short summary is given, which provides input for the main conclusions on the international comparison.

Denmark: simplified EPC for new homes
In Denmark most EPCs are issued by experts where the energy demand is calculated during an on-site visit. For single-family houses that are built less than 25 years ago an EPC may be issued without an on-site visit as the building regulation since that time gives a clear indication of the characteristics of the house and what measures might still be taken (5% of all single-family homes). However, this is not a possibility if changes have been made to the building that have affected its energy performance. For some rental properties, such as non-residential buildings and multifamily buildings meeting certain requirements, such as having a detailed and updated operational log, it is allowed to obtain an EPC based on measured energy consumption.

The calculation method of the energy performance is used for both existing buildings and new buildings which provides the possibility to compare labels. Generally, the validity of the label is 10 years, unless an energy saving potential of at least 5% with a payback time of less than 10 years is identified. Then the validity is reduced to 7 years. As this does not lead to more energy savings in practice, this is up for discussion because it only increases regulatory burden. The price of the EPC for small buildings is regulated by the government, but in practice prices are lower because of fierce competition. The relatively high prices in comparison with other European countries results from the higher general price level in Denmark. Recently, requirements for EPC experts have been tightened as it was found the quality of the labels was diminishing. It is too soon to conclude what the effect of this may be on the costs of EPCs.

Denmark has implemented the requirement to display the label in public buildings or buildings that are occupied by organization owned or funded by the public that are larger than 250 m^2. It has created discretionary room by requiring commercial buildings larger than 600 m^2 to display the label (instead of 250 m^2).

England: DECs increase regulatory burden, quality lacks due to lacking enforcement
In England the energy rating is different for residential and non-residential buildings. For residential buildings the asset rating is based on calculated energy demand of the building and a standard occupancy profile. The label also provides insight into the CO_2 emissions and potential costs that may be saved when all cost-effective recommendations are installed. However, this way of communicating the potential savings does not lead to home owners investing more in the energy efficiency of their building in practice. The asset rating for non-residential buildings is based on CO_2-emissions, so that the lowest rating is most energy efficient. The rating is compared to two benchmarks; the rating if the property would be newly built and the rating compared to the average of similar properties.

For public buildings larger than 250 m^2 that are (partially) occupied by public authorities a Display Energy Certificate (DEC) is issued. In contrast to EPCs these are based on an operational rating given the actual energy consumption in the three previous years and is compared to similar buildings (on a scale of 0 to 150, where 100 is typical). CO_2 emissions from electricity, heating and renewables in the past three years are also presented. The DECs have a validity of 10 years for buildings smaller than 1,000 m^2, for larger buildings the DEC must be updated annually. Discretionary room has been created here as there is no requirement to implement the recommendations on the DEC within the validity period of the DEC. The choice for this type label for public buildings is remarkable as it leads to an increase in regulatory burden to require a new DEC each year. At the same time, the effects on actual energy consumption are limited, especially given that the requirement to implement the recommendations is not implemented.

The EPCs and DECs are issued by accredited experts through the use of government approved software packages, which are also used to calculate the energy performance of new buildings. This is efficient as it improves comparison of the energy rating between existing and new buildings and reduces regulatory burden from having multiple systems in place. The certificates must be filed to a central electronic register in order to check compliance. Local authorities are responsible for this, but as they do not have to report this to the national government enforcement is low in practice. The Ministry of Housing, Communities and Local Government is responsible for quality control of the labels. Given that they are filed as a PDF to the register, the possibilities to check the quality of the rating is limited as the input data is not available. Possibly as a consequence of the lack of enforcement, the competition is fierce and the price and quality of the EPCs and DECs have gone down. The recent introduction of minimum energy efficiency standards for non-residential buildings and privately rented properties (see chapter 5) based on energy rating has led to a discussion about the quality of the labels as it highlights the need for a good quality control and enforcement system.

Germany: energy ID based on measured energy consumption not favorable
In Germany there are two different 'energy IDs' in use: one based on calculated primary energy demand and the other based on measured energy consumption. The measured energy consumption 'energy ID' is easier to issue, but is only allowed for a selection of residential buildings and non-residential buildings. The energy ID based on calculated energy demand is required for new buildings. Although this provides the possibility to compare between existing and new buildings, the adoption of two different systems does complicate comparability between buildings that have a different type of energy ID. This is a consequence of the fact that user behavior has a large effect on actual consumption in the case of the measured energy consumption. The rating is based on the calculated or measured primary energy demand expressed in kWh/m^2 per year and on the label a comparison is made with the minimum standards for similar new buildings and existing renovated buildings in order to benchmark the performance.

In practice, the measured energy ID does not provide a good insight of the energy performance of buildings as it is affected by the behavior of tenants and the energy ID is often issued for an entire building, instead of separate building units. The fact that the costs of energy are often included in the rent gives tenants no incentive to reduce energy consumption as they do not benefit from it in practice. Also, given the high demand for apartments in larger cities, commercial owners of residential buildings have no incentives to improve the energy performance of their buildings.

A display certificate is always included with energy IDs of non-residential buildings. Displaying the label is required for public buildings only, but other non-residential building owners are not required to display the label. In this way Germany has created discretionary room by which it limits the regulatory burden from the system.

The prices of calculated energy IDs are relatively high in Germany as a consequence of the high requirements for assessors. Government encourages certification through the calculated method by subsidizing a large part of the costs for private home owners so that the price difference between the two is practically eliminated. Assessors are themselves responsible to check their compliance with the requirements at risk of being fined, which reduces regulatory burden from the control system.

Quality control is delegated to the German Institute of Building Technique which performs an automated quality check and a (partial) check on the input data for a selection of energy IDs. In case of non-compliance of quality, local governments are informed as they are responsible for enforcement measures. They are also responsible for the control of the availability of the certificates and fining non-compliant building owners. From interviews it became clear that, in practice, it happens that different assessors issue different labels for buildings, meaning that expert EPCs in Germany are not always consistent.

Norway: simplified labels free of charge
Norway, as a non-EU member, has implemented the EPBD of 2002 officially and parts of the EPBD of 2010 unofficially. There are also two EPCs available. The first one, which only applies to residential buildings is similar to the Dutch system of online energy labels. The software program that generates the labels is connected to a database of buildings in which many characteristics of the building stock are registered (for example, based on building standards). Private home owners may obtain this online label free of charge. They may choose a simple registration or a more detailed registration for which more details or refurbishments have to be

provided. Only with a detailed registration are owners able to get a better energy rating than based on the building standard. As the government requires all building owners to have a valid EPC at all times (not only in case of transactions), this system reduces regulatory burden considerably. The Norwegian system shows that an online label can be implemented using kWh per square meter per year as a metric.

The second EPC in circulation in Norway is the expert EPC that is based on calculated energy demand and requires an on-site visit, similar to other countries. The expert EPC is required for new and non-residential buildings. The Energy Certification System can therefore also be used in order to ensure compliance with minimum standards. The certificate that is produced as a result is registered in the same database as the inspection reports. The efficient design of this system reduces regulatory burden for the government.

Costs for expert EPCs for homes are at least € 200, for non-residential buildings it ranges between € 1,000 and € 10,000. The requirement regarding the display of the certificate in public buildings is extended to all non-residential buildings in Norway. However, given that the EPBD of 2010 was never officially implemented, this is only required for buildings larger than 1,000 m^2. It is not clear why this decision was made, as it, similarly to England leads to a respective increase and reduction of regulatory burden.

EPC experts are responsible themselves for meeting the requirements in case of control. The quality of the system is ensured by automatic control of the input data in the software system and potential buyers/tenants are kept responsible for checking the input data used to calculate the energy performance. This reduces the regulatory burden resulting from a control system for the government and may enhance the effect on awareness.

Portugal: different labels at the time of issuance less transparent
In Portugal all EPCs are issued by experts and require an on-site visit. The certificate presents the performance of the overall performance of the building and three additional indicators for heating, cooling and hot water. These indicators are all compared to the minimum standards of new buildings at the time of issuance, which complicates comparability of labels from different years. The energy performance of the building is based on primary energy demand in kWh/m^2/year, but also CO_2 emissions and the renewable energy component are shown. However, despite the extensive information that the EPC provides, this does not lead to sufficient investments in the energy efficiency of buildings. Therefore, the layout of the EPC is now being changed to include a comfort indicator as well. The greater emphasis on comfort is meant to enhance investments and energy savings.

Regulatory burden is quite high given that EPCs may only be issued by experts. Also, the validity of the EPC of non-residential buildings is 6 years instead of the maximum of 10 years, which increases regulatory burden while it is not clear whether this leads to more or earlier investments in the energy efficiency of the building.

Costs of the EPC range between € 80 and € 300 for residential buildings and an additional fee must be paid to upload it into the national database. This system, managed by government agency ADENE, automatically checks the input data. They are also responsible for random quality checks and the obligatory exam all experts need to pass before being allowed to issue EPCs. Compliance is ensured by prohibiting passing of transactions without the availability of EPCs with solicitors. However, sellers of the property are still kept responsible.

The requirement to display the label in Portugal in public buildings was extended to all non-residential buildings. However, the minimum size of these buildings is kept at 500 m^2. This leads to a regulatory burden that is lower than what it would be if EPBD requirements were implemented.

2.6.1 Conclusions on the international comparison

Effects of EPCs on energy savings also limited in other European countries
The experience with different type of EPCs in other European countries does not lead to different results concerning the effects of the certificates on energy savings than in the Netherlands. In all countries the effect of the system of EPCs on investments in the energy efficiency of buildings is limited. It does not seem to matter whether EPCs are issued by experts based on an on-site visit, on measured consumption or on building owners providing important characteristics online. Also, no other effects were seen in countries where the energy demand is expressed in kWh/m^2 per year or when a direct projection of the potential cost reduction from energy savings is given. The main effect from the system of EPCs in all countries was increased awareness among building owners concerning the energy performance of their buildings. The effectiveness of a system of energy labels to incentivize energy saving measures, however, seems debatable.

The fact that the type of EPC does not seem to matter for energy reduction, gives reason to implement a system that limits regulatory burden as much as possible. This resonates with the experiences in other countries when requirements of the EPBD are set more stringent than the EPBD prescribes. For example, when the validity period of the EPC is less than the maximum of ten years or the requirement to display the label is extended to more buildings, this leads to discussions as this increases regulatory burden without additional effects in terms of energy consumption. Also, from the interviews follows that in many countries discussions are being held on how to improve the communicability of the certificates and more closely relate to reasoning of building owners to induce more energy saving measures being taken. In Denmark, Germany, Portugal and Norway this is done by focusing on the comfort and quality of the indoor climate. This seems to be a communication effort mainly; research that shows a relationship between energy saving measures and comfort has not been provided.

Regulatory burden relatively low in the Netherlands compared to other countries
The system of simplified energy labels for privately owned homes in the Netherlands and Norway is one of the most extensive measures to implement EPCs while minimizing regulatory burden. It comprises a large share of the building stock and affects a large share of potential costs, especially for private home owners. Other countries also take measures to reduce regulatory burden, but these often lead to limited cost reductions only. For example, the EPCs in Denmark that do not require an on-site visit are only applicable to 5% of single-family houses.

Though the other researched countries do not create as much discretionary room to limit regulatory burden as is done in the Netherlands, there are some lessons that may be learned to further reduce the regulatory burden from the implementation of the EPBD. These include:

- All countries included in the study have one calculation method for the energy performance of new and existing buildings. This generally improves comparability between labels and, more importantly, reduces regulatory burden.
- In Denmark, England, Germany and Portugal the regulatory burden is limited by not fully implementing the EPBD requirement to display the EPC in commercial buildings larger than 250 m^2. In England, Germany and Portugal this is done by making it voluntary for all commercial buildings. Denmark has limited this to commercial buildings larger than 600 m^2. The Netherlands may also reduce regulatory burden this way.
- In England the compliance costs are limited by not requiring public buildings to implement cost efficient recommendations within the validity period of the DECs. This seems like a reasonable consequence from the obligation to renew the DECs every year for buildings larger than 1,000 m^2. However, it also applies to smaller buildings of which the DEC has a validity period of ten years. Forcing building owners to invest in buildings within ten years leads to economically unfavorable situations as investments have to be performed earlier ore more often than is cost efficient without leading to much additional effects. The Netherlands may also reduce regulatory burden by discontinuing this requirement.
- In Norway regulatory burden is limited by combining the registration system of EPCs and inspection reports and encouraging building owners to combine the issuance of the EPC with inspection of technical building systems.

2.7 Conclusions and recommendations

Implementation in the Netherlands cost efficient in light of the main aim of the directive
It can be concluded that the Netherlands have implemented the directive regarding the system of energy performance certificates in a relatively cost-efficient way through the introduction of the simplified energy labels for the majority of residential buildings. The main effect from the system of energy performance certificates is the increased awareness about the energy performance of buildings. However, no direct link was identified between the system and investments in energy saving measures, not as a result from the simplified energy labels nor from the expert EPCs. This conclusion is supported by the international comparison as also in other European countries no result was found between the issuance of different type EPCs and investments in the energy efficiency of buildings. Therefore, it seems reasonable to implement a system which minimizes regulatory burden. The Dutch system of simplified energy labels has been successful at this, as cost are low and the labels provide a sufficient indication of the energy performance for the majority of residential homes and recommendations on how to reduce energy demand.

There were two choices made in the introduction of the current system which were suboptimal. Firstly, the choice for a different calculation method for existing and new buildings led to the issuance of two energy ratings for new buildings in some cases. And secondly, the EPBD did not prescribe the issuance of EPCs or energy labels for buildings within 10 years after being built. In Dutch regulation, however, a simplified label was also required for new residential buildings with the introduction of the simplified energy labels. This is not cost efficient as it increases regulatory burden, while there are practically no benefits in terms of lower energy consumption as measures are rarely taken in buildings within the first ten years after being built.

Retaining system of simplified labels as a means to limit regulatory burden
The significant increase in costs of expert EPCs has to be compared to the value and benefits of the EPC. As noted, a certain positive effect of EPCs on energy saving investments cannot be ruled out based on conducted studies. However, there is no reason to assume that these effects are significantly larger when using an expert EPC compared to using an online EPC. Currently, there are no policies in effect that use the EPC as a basis[105], which means that a (possible) lack of accuracy does not have large consequences. Furthermore, expert EPCs are not fully accurate either. Considering the above and the significant cost increase, EIB concludes that the use of simplified energy labels could well be the appropriate design.

Additional ways on how to improve the system or reduce regulatory burden
Further exploration of the possibilities of a new simplified energy label may also include other ways to create discretionary room in order to improve the system at limited costs and reduce regulatory burden. In practice the European Commission allows more discretionary room than explicitly stated in the EPBD, as long as the equivalence or the effects of alternatives are clearly presented. Some directions which may be examined further are:

- The opportunity that the widespread installation of smart metering systems in all residential homes and small businesses in the Netherlands offers. These systems can provide a detailed insight in the energy performance of buildings, actual energy consumption (as opposed to calculated energy demand) and the influence of behavior from users/occupants of buildings. In that way it may contribute to greater awareness about energy consumption and the role of building characteristics and behavior as determinants[106]. Alternatively, the quality of the information and recommendations in the EPC may be improved relatively cost-efficiently and thereby improve the chance of households taking energy saving measures.
- The registration of EPCs and/or energy labels and inspections reports may be combined in order to improve knowledge on the state of the building stock and the possibilities for quality control, while regulatory burden may be reduced.

[105] The ‘woningwaarderingsstelsel’ and RVV uses EPCs, but only expert EPCs are used to this effect.

[106] This is already stimulated through the ‘convenant 10PJ energiebesparing gebouwde omgeving’.

- The validity period of ten years for an EPC is prescribed by the EPBD, but this is not substantiated. However, it does lead to extra costs, especially for social housing corporations (as a consequence of incentives from the 'woningwaarderingsstelsel') and owners of commercial buildings larger than 250 m^2 that are frequently visited by the public that are required to have a valid EPC of their building stock at all times. Even private home owners might in some cases have to purchase a new energy label that is exactly the same as the previous one only because the validity period of the label is expired. With the existing simplified energy label, the costs are relatively small, but given the reintroduction of costly expert EPCs this would become quite costly. An initial digital check, which might include sending additional information (from an involved real estate agent) or a video call instead of on-site visits, may limit these costs. The existing database may provide insight into how often identical labels are provided in practice, which is important to determine the potential reduction in regulatory burden from an arrangement to extend the validity period of EPCs and/or energy labels.
- The option to implement the directive less strictly than prescribed. England and Portugal, for example, have done this with regards to public buildings. In England, public buildings are not required to implement the recommendations in the EPC within its validity period. Portugal only requires certain buildings larger than 500 m^2 or 1,000 m^2 to display the certificate. These may also be ways the Netherlands could reduce the regulatory burden from the implementation of the EPBD. It will have to be motivated to the European Commission that the Netherlands are working towards the aim of energy consumption reduction (through alternative policies).
- The introduction of an extensive building database as in Norway that saves all the input data from the expert EPCs. Generally, such a system is valuable for policy making, but especially when expert EPCs are reintroduced, this may provide the possibility of limiting the regulatory burden when an expert EPC based on the NTA 8800 has to be made for a second time. As the geometry of the building does not change often and may only be altered partially, the expert could mostly rely on the input data and check what adjustments have been done since the last EPC was issued. Only a part of the input data would need to be changed to issue a new EPC. Depending on the adjustments that have been made to the building, this (initial) check might even be done without an on-site visit. As a consequence, an expert EPC including an on-site visit may only be required once. This may, without in any way reducing the quality of the EPC, create the opportunity to serially issue them to owners of similar houses, which may reduce the costs further. This would also reduce costs for social housing corporations and commercial owners of houses who are obliged to always have a valid EPC (instead of only in case of selling their property).

3 Minimum energy performance requirements

This chapter will focus on the way in which the EPBD has been implemented into national legislation concerning minimum energy performance requirements. First of all, an outline of what the directive prescribes will be presented, followed by an evaluation of the room for discretion that may adopted by individual member states. Secondly, the transposition of the respective articles into Dutch legislation and the underlying considerations will be discussed. This will be concluded by a comparison of the expected and actual regulatory burden that stems from the implementation in the Netherlands. Moreover, an evaluation of how the Directive has been implemented in other European counties is included in order to identify what alternatives have proven to be (less) successful in terms of limiting regulatory burden. Within this evaluation, special attention is devoted to the role that cost-optimal level studies have played in determining the minimum energy performance requirements across countries. Finally, the conclusions and recommendations for future policy design will be provided.

3.1 What does the directive prescribe?

The directive of 2002 requires member states to set minimum energy performance requirements for new buildings and for buildings larger than 1,000 m^2 that undergo major renovations. The ambition level of these requirements is not specified by the directive. However, they must be revised at least every five years and updated given the technical progress in the building sector.

The 2010 recast of the directive prescribes that member states must set cost-optimal minimum requirements for new buildings, existing buildings of all sizes that undergo major renovation and building elements that are replaced or retrofitted. Moreover, the directive prescribes that countries are required to assess the cost-optimality of their minimum requirements based on a comparative methodological framework provided by the European Commission. Individual countries are to report on the inputs used and the results of the calculations to the European Commission and must justify any deviation of more than 15% from cost-optimal levels[107]. Although the directive prescribes that the requirements should be determined based on the cost-optimality principle, Member States have the right to set their requirements at a level that is more ambitious than the cost-optimal level.

For new buildings the minimum requirements must evolve into a requirement of nearly zero-energy buildings (NZEB) by 2021 and for newly built governmental buildings by 2019. However, the definition of the NZEB level is not formally specified and does not need to be more ambitious than the cost-optimal level. National governments are expected to lead the way when it comes to energy efficiency of buildings by setting targets for increasing the number of nearly zero-energy buildings in general and specifically for buildings that are occupied by public authorities.

Minimum energy performance requirements must be established for building elements that are part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are retrofitted or replaced and for technical building systems when they are installed, upgraded or replaced. In case of new buildings or major renovations, member states must stimulate the installation of intelligent metering systems.

The 2018 recast of the directive prescribes that a method is used that results in an energy performance indicator expressed in kWh primary energy/m^2/year, both for the calculation of energy performance certificates as well as for setting minimum requirements that apply to new buildings.

[107] For a more detailed explanation of how the cost-optimal level and range are to be determined see paragraph 3.2.4.

3.1.1 In what areas does the directive provide member states with room for discretion?

In 2002 the EPBD established that countries may choose a definition for major renovations: one comprises that the total costs of renovations relating to the building envelope and technical building systems constitute 25% or more of the total value of the building excluding the land on which it is situated, whereas the other specifies that at least 25% of the surface of the building envelope undergoes renovation.

Countries may also set different requirements for new and existing buildings and buildings of different types and functions. Member states also have discretion to exclude a selection of building types listed by the EU from these requirements if valid arguments exist.

The directive demands requirements to be set for building elements that are part of the building envelope and may have a significant impact on the energy performance of the building when retrofitted or replaced, but it does not specify what is considered to be a significant impact. This enables countries to decide on what components of the building envelope are subject to minimum energy performance requirements when replaced or retrofitted.

As of 2010 the requirements are calculated according to the cost-optimal framework provided by the European Commission, but countries still have some room for discretion with respect to how they implement the model and whether they choose to set the requirements at the cost-optimal level in terms of financial or social costs. For example, Member States are allowed to apply the (social) discount rate that is valid in the respective country and select the (number of) reference buildings to be used in the calculations. This enables countries to base the minimum requirements on a reference building for which the cost-optimal level is less ambitious than for other reference buildings. Finally, the fact that the NZEB level is not specified by the directive provides member states with the possibility to define NZEB standards with a great amount of freedom and allowing cost-optimality to prevail.

3.2 How is the directive implemented into national legislation in the Netherlands?

The directive's requirements concerning minimum energy performance have been implemented in the Netherlands as part of the national building decree in 2012 (Bouwbesluit). Figure 3.1 shows the implementation of the EPBD directive over time with respect to the minimum energy performance requirements for buildings and building components.

The minimum requirements for new buildings that follow from the EPBD 2010 have been expressed in terms of an energy performance coefficient (EPC), a measure that has been in place since 1995, which indicates how much energy is used for heating, cooling, ventilation, hot tap water and lighting compared to a similar building that was constructed in 1990. For example, an EPC value of 0.6 for residential buildings means that the theoretical energy use of the respective new building comprises 60% of the theoretical energy use of the reference building, which has an EPC of 1.0. In the same way, a hospital with an EPC value of 2.6 uses 30% less energy compared to a similar hospital built in 1990 (EPC of 3,8 in 1990). Table 3.1 gives an overview of the development of minimum energy performance coefficients for new buildings over time according to the building type and function. The minimum energy performance requirements vary across different building types based on their physical characteristics. For example, the physical characteristics of a hospital deviate substantially from a general practitioner's office, hence the difference with respect to the EPC-requirements. Developments of minimum energy performance requirements for technical building systems and thermal insulation in the Netherlands are included in Appendix C.

Figure 3.1 Implementation of the EPBD regarding the minimum energy performance requirements in national legislation in the Netherlands

2003	EPBD 2002/91/EG enters into force
	Implementation into Dutch legislation
2005	Minimum value Energy Performance Coefficient for residential buildings tightened from 1 to 0,8
2008	Tightening of minimum Energy Performance Coefficients for most non-residential buildings
	First revision EPBD
2010	EPBD 2010/31/EU enters into force
	Implementation into Dutch legislation
2010	Further tightening of Energy Performance Coefficient for residential buildings to 0,6
2012	• Building Decree 2012 enters into force • Mimum requirements for thermal insulation of new buildings and renovations
2013	• Thermal insulation requirements for new buildings also apply to major renovations • Minimum efficiency requirements for technical building systems
2015	• Further tightening of Energy Performance Coefficients for most residential and non-residential buildings • NZEB 2020 (2019 for buildings owned by the government) • Miminum thermal insulation requirements with respect to individual building components

Source: EIB

The definition of major renovations that applies in the Netherlands is based on renovations to a minimum of 25% of the integral building envelope, as this definition is said to be less costly, clearer and leaves less room for interpretation. For the determination of the cost-optimal levels for new buildings and building components, the Netherlands have chosen to use the calculations based on financial costs as the results did not vary much compared to the calculations based on social costs. Moreover, the financial costs better coincide with preceding policies concerning the energy performance of buildings[108].

[108] RVO (2013), Verslaglegging kostenoptimaliteit energieprestatie eisen Nederland, executed by DGMR Bouw.

Table 3.2 Minimum performance requirements from 2003-2015 for different building types in the Netherlands

	1995	2003	2005	2008	2010	2015
Mobile homes	-	-	-	-	1.3	1.3
Residential buildings	1.0	1.0	0.8	0.8	0.6	0.4
Day-care centers	2.4	2.2	2.2	2.0	2.0	1.1
Prisons	2.2	1.9	1.9	1.8	1.8	1.0
Health care buildings with bed area (hospitals)	3.8	3.6	3.6	2.6	2.6	1.8
Health care buildings (other than with bed area)	1.8	1.5	1.5	1.0	1.0	0.8
Office buildings	-	1.5	1.5	1.1	1.1	0.8
Accommodation not in lodging structure (conference facilities)	-	1.4	1.4	1.4	1.4	1.4
Accommodation function in a building for accommodation	-	1.9	1.9	1.8	1.8	1.0
Educational buildings	1.5	1.4	1.4	1.3	1.3	0.7
Sports buildings	2.2	1.8	1.8	1.8	1.8	0.9
Retail buildings	3.5	3.4	3.4	2.6	2.6	1.7

Source: Building Decree 2003 and 2012

3.2.1 What alternatives have been considered in the process of implementation?

In 1995 there was already a system in place that enabled the calculation of the energy performance for new buildings based on the energy performance coefficient. Moreover, a different methodology to calculate the energy performance for existing buildings has been in place since 1995 as well. The reason for developing different methodologies for new and existing buildings was that in the case of new buildings more details are known. For accuracy reasons these were included in the EPC calculations. A less comprehensive method was used to determine the energy performance of existing buildings, based on the details that are known in the existing building stock. This resulted in the development of the Energy Index which was later translated into the system of energy labels. With the implementation of the EPBD, the existing systems to determine energy performance have been kept in place, resulting in the use of different methodologies for new and existing buildings.

With respect to the selection of a definition for major renovations, three options have been evaluated[109]. The first two options are prescribed by the EPBD and define major renovations as follows: the total costs of renovations relating to the building envelope and technical building systems constitute 25% or more of the total value of the building excluding the land on which it is situated or at least 25% of the surface area of the building envelope undergoes renovation. A third option that has been considered is not to introduce a definition of major renovations, but to specify minimum requirements for individual components that are part of the building envelope instead. Out of the first two options, the initially estimated regulatory burden was lowest in the case when major renovations constitute adjustments to at least 25% of surface of the building envelope. Besides, this definition is clearer and leaves less room for interpretation.

[109] SIRA consulting (2010), Gevolgen administratieve en uitvoeringslasten herziene EPBD 2010.

However, for the option that specifies minimum requirements for individual building components instead of defining major renovations no additional administrative costs were identified. The idea that the compliance costs for this option might be higher as component requirements apply to more than just major renovations has led to the selection of the option of 25% of the surface area of the building envelope.

With respect to benchmarking the current minimum energy performance requirements for buildings and building components against the cost-optimal levels, it has been considered to use the financial or social costs. The financial costs have been chosen as the cost-optimal levels were found to be similar for both calculations. The considerations regarding the level of the minimum requirements have not been well documented. From interviews it became clear that the industry has advocated a differentiation of the thermal insulation requirements for different components of the building envelope. Rather than requiring an Rc value of 5 for all elements, it was evaluated whether it would be better in terms of cost-optimality to differentiate the Rc-requirements for roofs, walls and floors. After the results of a study confirmed this, the differentiation of the Rc-requirements was incorporated into the Building Decree 2012.

The decision-making process that led to the tightening of the EPC-threshold to 0.4 in 2015, is fairly non-transparent[110]. Cost optimality studies were conducted that show that the chosen requirements are not cost optimal, which was known at the time. From expert interviews it can be concluded that stakeholder committees were installed, but that their influence was limited. However, it has been pointed out in one interview that a rise (approximately € 100 per m^2) of the investment costs that would not be fully compensated by a lower energy bill, was deemed acceptable by the committee. In conclusion, the decision to let go of cost optimality seems to have a political nature. More transparency in the decision-making process could lead to a better understanding of the decisions made and increase support for chosen policies.

Concerning the requirements of EPCs, it was considered to present an energy performance coefficient for new buildings at the permit application *and* at delivery or at one of the two instances. The costs related to the requirement to submit an EPC calculation twice was about twice as large (€ 15.1 million) compared to only submitting one at the permit application *or* delivery (€ 7.5 million)[111]. It was chosen to have an EPC acquired at application only.

3.2.2 What control system is in place?

The EPBD articles that concern minimum energy performance requirements have been transposed into existing legislation that applies to construction, which means they are part of the existing quality control mechanisms. In the Netherlands municipalities are responsible for the issuance of building permits. The energy performance coefficient calculation has been integrated in the permit application. The Netherlands Enterprise Agency (RVO) checks for a sample of all permits whether they comply with all the legal requirements. If this is not the case, the municipality is notified and responsible for legal action.

Municipalities or regional environment services also check during construction whether the building complies with the design that was included in the permit application and in case of non-compliance might issue a 'cease-work' until compliance is met. Interviews have revealed that within the current control system, where municipalities or regional environment services are responsible for monitoring and enforcement of the building decree, in practice safety has priority and control on minimum energy performance requirements is minimal. However, a new law will be in place from January 2021 (Act on Quality Assurance for construction (Wet kwaliteitsborging voor het bouwen)) which has the aim to put more emphasis on the quality of buildings, the energy performance and the extent to which buildings are built in agreement with the blueprint for which the permit has been granted.

[110] This is also the case for the definition of minimum requirements of NZEB buildings.

[111] SIRA consulting (2010), Gevolgen administratieve en uitvoeringslasten herziene EPBD 2010.

3.3 Regulatory burden and benefits in practice

As minimum energy performance requirements were already in place before the implementation of the EPBD, the directive has mostly affected existing legislation within this area. Tightening the energy performance requirements for new buildings and major renovations does not alter the application and evaluation procedure for building permits. Consequently, the additional regulatory burden was perceived to be limited. However, it should be noted that tightening the level of minimum requirements results in higher compliance costs, which has not been included in studies that assess the regulatory burden from the implementation of the EPBD 2010[112]. Within the context of minimum requirements, compliance costs refer to the costs made by parties to comply with the regulations regarding construction, i.e. an increase in costs due to higher quality requirements. Besides the compliance costs, organizations within the construction sector are faced with one-off costs related to familiarizing with the consequences of adjusted requirements. Although these administrative costs have not been accounted for in earlier studies, interviews with stakeholders revealed that they are substantial. Especially the large amount of adjustments over time has resulted in considerable costs related to familiarization. These costs are rather broad in the sense that they are incurred by construction and installation companies, developers and consultants. Nevertheless, compliance costs constitute the largest share of the regulatory burden related to imposing minimum energy performance requirements.

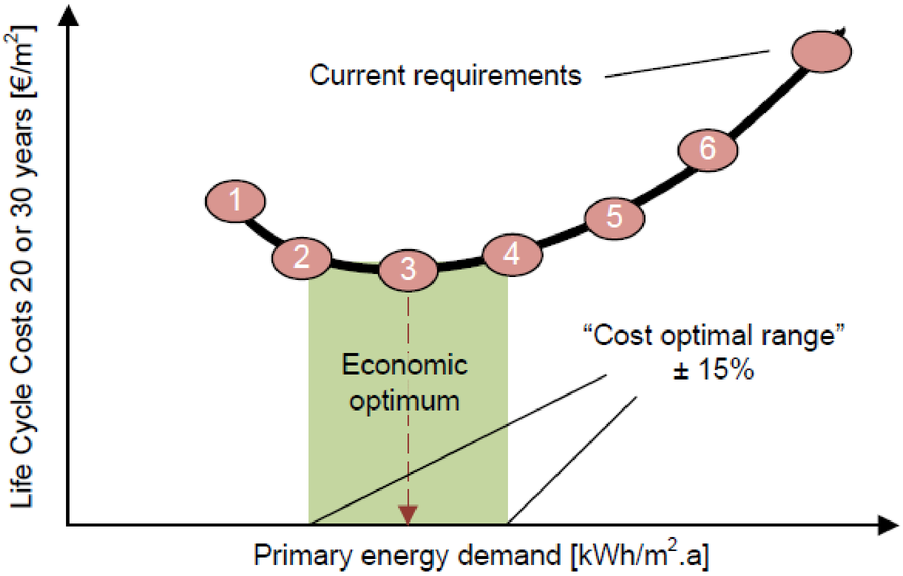
Determination of cost-optimal levels based on the comparative methodological framework
As the compliance costs constitute the largest share of the regulatory burden related to minimum energy performance requirements, it is important to evaluate the costs of the requirements in respect to the financial benefits. In order to do so, the minimum requirements should be determined in the context of the cost-optimality principle. The European Commission has offered a methodological framework that member states have to use in order to determine cost-optimal levels with respect to the minimum energy performance requirements for buildings and building components (Delegated Regulation (EU) No 244/2012). The cost-optimal level should lie within the range of performance levels where the cost-benefit analysis over the lifecycle is positive. All these performance levels are considered to be cost-efficient as the investment will be earned back by future energy savings. Of all the cost-efficient points there is one performance level that has the largest net present value, indicating that this is the best investment opportunity and as such represents the cost-optimal level. Member states are required to periodically review whether the minimum energy performance requirements in force are still in accordance with the cost-optimal levels. The minimum requirements are allowed to deviate 15% from the cost-optimal point, meaning that they should lie within the bandwidth referred to as the cost-optimal range, with the lowest life cycle costs per square meter as the economic optimum (see figure 3.2). However, member states do have the right to set requirements that are more ambitious than the cost-optimal level. For each reference building, the cost optimal level and range should be determined individually. When multiple packages of energy saving measures can be identified as the cost-optimal point, the current requirements will need to be benchmarked against the package with the lowest primary energy use.

The difference between the current minimum energy performance requirements and the cost-optimal levels is to be calculated as the average of all the minimum energy performance requirements in force and the average of all cost-optimal levels of the calculation used as the national benchmark of all reference buildings used. It is up to the Member State to introduce a weighting factor representing the relative importance of one reference building (and its requirements) over another[113].

[112] The latest assessment concerning the tightening of minimum energy performance requirements up to NZEB levels, executed by SIRA consulting, has incorporated compliance costs as part of the regulatory burden.

[113] Guidelines accompanying Commission Delegated Regulation (EU) No 244/2012.

Figure 3.2 **EU framework to determine the cost-optimal point and cost-optimal range with respect to minimum energy performance requirements in buildings**



Source: Royal HaskoningDHV

The methodology is twofold. Financial costs and benefits as well as total social costs and benefits have to be calculated. Member states are allowed to base their cost-optimal levels on one of these two indicators. The Netherlands calculates the cost-optimal levels of both indicators, but chooses to determine minimum requirements based on the financial calculation. However, both methods produce similar outcomes as will be shown later. The methodology distinguishes the following costs: 1) initial investment costs (including reinvestment costs throughout the product[114] lifetime), 2) annual running costs and 3) the residual value. Moreover, savings on the energy bill are included as benefits.

The calculation of the financial costs for building owners incorporates taxes, whereas subsidies are not taken into account. The social cost-benefit analysis excludes taxes, but values saved CO_2-emissions in monetary terms (expressed in euros). Subsequently, a net present value has to be derived over all additional costs and benefits that occur over the calculation period. In the case of residential and public buildings a calculation period of 30 years has to be applied. For commercial, non-residential buildings the calculation period to be used is 20 years. Member states are allowed to apply the in the respective country valid (social) discount rate. However, they are also required to carry out sensitivity analyses based on a high and low discount rate[115]. With respect to the benefits related to saved CO_2-emissions over time, no discount rate is applied. Cost-optimal levels are defined as the case where all costs of energy saving measures are earned back by a lower energy bill and less CO_2-emissions and further tightening of the minimum requirements results in increasing costs. In the cost-optimal situation, the benefits

[114] 'Product' implies single elements that are part of the building. This definition is chosen as in the case of major renovations costs for individual elements have to be calculated. For new buildings the initial investment costs are based on building characteristics.

[115] The sensitivity analyses carried out on the financial calculations apply real discount rates of 3,5% and 6,5% for residential buildings and 6,5% and 9,0% for non-residential buildings. With respect to the social cost benefit analysis, real discount rates of 2% and 4% are applied.

sufficiently compensate the compliance costs for citizens and organizations and hence proportionality is guaranteed.

Cost-optimal levels of the minimum requirements can change over time due to increased or decreased investment costs and improvements with respect to the energy performance, but also a higher energy price or valuation of CO_2-emissions. Hence, it is possible to tighten the cost-optimal levels without creating a larger burden for building owners.

Cost-optimal levels of the Dutch minimum requirements for new buildings: EPC 0.6
The Dutch minimum energy performance requirements for new domestic buildings that came into force in 2010 (EPC 0.6) have been evaluated based on the previously introduced cost-optimal level methodology. In the respective study[116], DGMR Bouw has applied a real discount rate of 5.5% for residential buildings and 8% for non-residential buildings. The social costs and benefits are based on a real discount rate of 3%. The results of this study show that setting the threshold of the energy performance coefficient to 0.6 for residential buildings is in accordance with the cost-optimal level. In figure 3.3 the EPC-level is represented by Q/Q, which refers to the rate between the EPC of a particular set of energy saving measures and the required EPC. A value of 1 implies that the EPC of the set of energy saving measures equals the minimum requirement (0.6 for residential buildings), whereas a lower value indicates that the energy performance of the set of measures is better than required. Hence, points to the left of 1.00 on the horizontal axis shows the outcomes for EPC-levels that are more ambitious than the current requirement, whereas points that lie right of 1.00 represent EPC-levels that are less ambitious.

Figure 3.3 shows that the net present costs of different sets of energy conservation measures that lead to an energy performance coefficient of 0.6 are nearly zero and become larger when the energy performance is improved[117] (moving left along the horizontal axis, to the left of the red line), leading to higher net present costs as visible in the left part of the figure. For most non-residential buildings the threshold was set slightly above the cost-optimal level, but still within the allowed bandwidth prescribed by the regulation. Only for offices and healthcare buildings, there was significant room for further tightening of the energy performance requirements (figure 3.4 presents the calculations for offices), implying that more stringent requirements would have led to more energy saving without increasing net life cycle costs.

Actual versus theoretical energy saving

The energy savings calculated in the cost-optimal studies conducted by DGMR are based on theoretical assumptions, using EPA-software packages. In her dissertation, Majcen[118] (2016) has researched the difference between theoretical and actual energy savings as a result from improving existing housing stock. The dissertation points out that significant differences exist between theoretical and actual energy use. Dwellings with high energy classes generally use more energy than software packages predict. A similar study has not been conducted for new buildings, but it might be expected that energy savings as a result of tightening EPC values are overestimated as well. This could influence outcomes of cost optimality studies and should be taken into account when interpreting results of DGMR studies presented here.

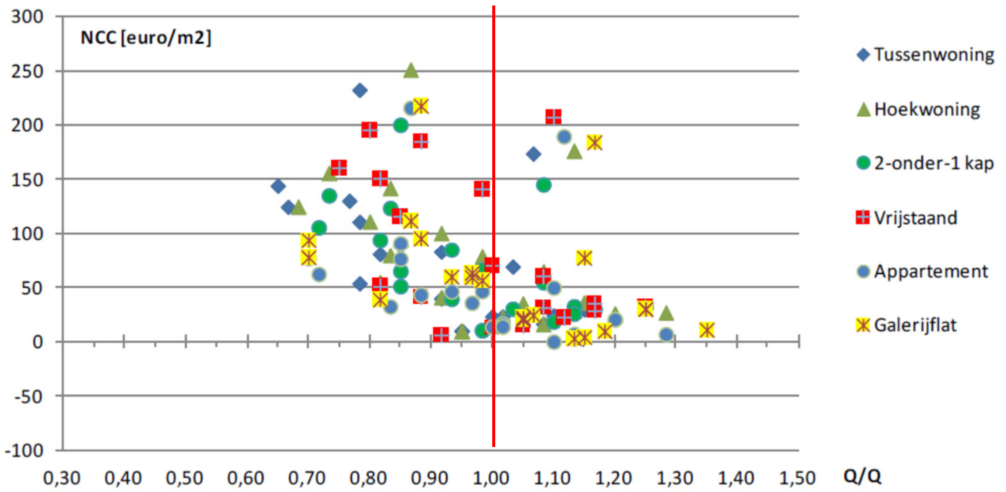
[116] RVO (2013), Verslaglegging kostenoptimaliteit energieprestatie eisen Nederland, executed by DGMR Bouw.

[117] Q/Q refers to the rate between the calculated energy demand (expressed as the value of the attained energy performance coefficient) and the required energy performance coefficient. A value of 1 implies that the calculated energy demand of the respective set of energy conservation measures equals the minimum requirement (0,6 for residential buildings), whereas a lower value indicates that the energy performance of the set of measures is better than required.

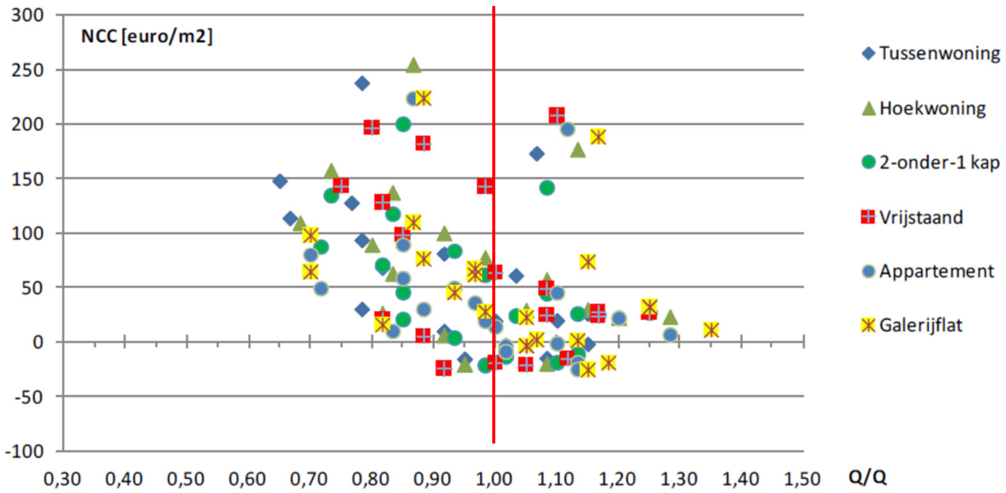
[118] Majcen, D. (2016), Predicting energy consumption and savings in the housing stock, Delft.

Figure 3.3 **Additional net present cost of energy saving measures in different residential buildings in the Netherlands[1], EPC 2010**

Financial costs and benefits for building owners



Social costs and benefits

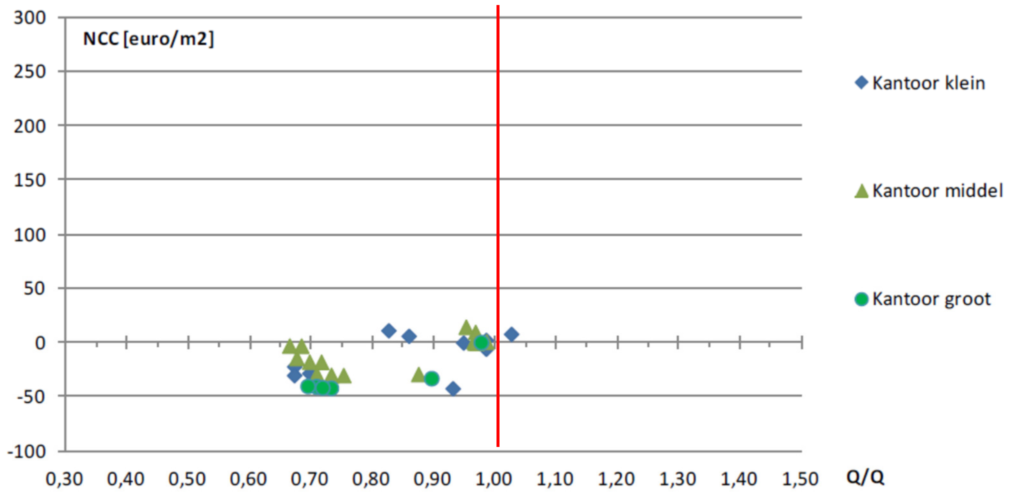


[1] For each type of building the net present costs are calculated for different sets of energy conservation measures. Red line indicates EPC of 0.6.

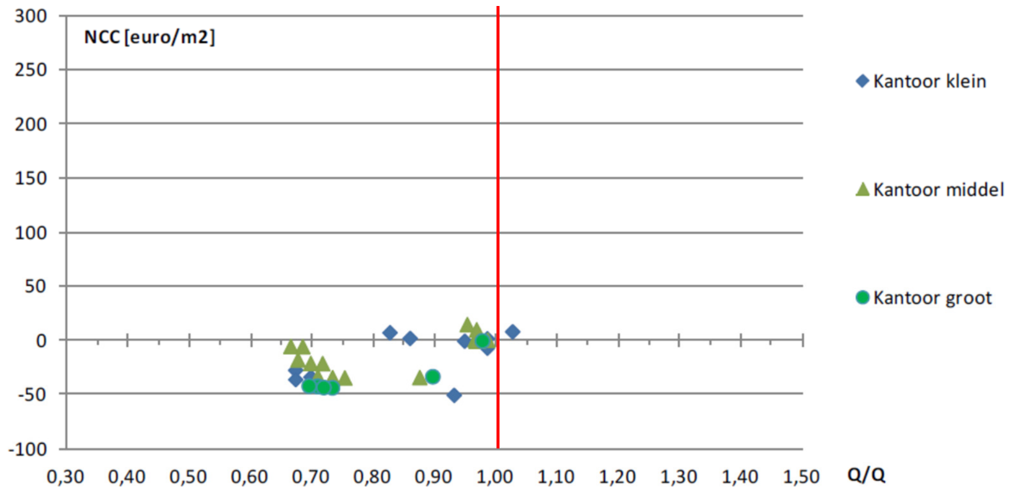
Source: DGMR Bouw

Figure 3.4 Additional net present cost of energy saving measures in office buildings in the Netherlands[1], EPC 2010.

Financial costs and benefits for building owners



Social costs and benefits



[1] For each type of building the net present costs are calculated for different sets of energy conservation measures. Red line indicates minimum requirements.

Source: DGMR Bouw

Further tightening of the EPC threshold required letting go of cost-optimality: EPC 0.4
As of 2015, the threshold of the energy performance coefficient has been set to a more stringent level (EPC 0.6 to 0.4) in order to prepare the construction sector for the requirement that all new buildings must comply with NZEB standards by the end of 2020[119]. This could only be attained by letting go of the cost-optimality principle. This is confirmed by a study carried out by W/E advisory and Arcadis[120]. Again, the financial costs for building owners as well as social costs and benefits were calculated.

The consequence of tightening the energy performance coefficient threshold is a rise in construction expenditures and hence higher prices for new buildings. Over the period 2015-2019 about 60,000 residential buildings were subject to these tightened minimum requirements. This has caused construction costs to rise by about € 7,000 for multi-family houses and by more than € 9,000 for single-family houses (€8,500 on average). In total this amounts to compliance costs of approximately € 500 million per year. Additionally, it causes the yearly (maintenance) expenditures to rise as well (about € 50 to € 100 per year or € 3 million to € 6 million based on 60,000 residential buildings, depending on the reference building). However, these costs technically fall outside the scope of regulatory burden.

The most important benefit for the building owner is, apart from a (possibly) more comfortable indoor climate, a reduced energy bill. According to the outcomes of the study, the savings in terms of energy consumption amounted to about € 350 per year for the average single-family house and more than € 200 for multi-family houses (VAT and other taxes included). These benefits also technically fall outside the scope of regulatory burden, but do provide information with respect to the proportionality of the measure. The findings of the W/E and Arcadis study show that between one- and two-thirds (€ 170 million to € 340 million) of the initial investments of € 500 million will not be earned back in financial terms. Hence, evaluating the proportionality of this adjustment based on financial costs to building owners paints an unfavorable picture. Tightening of the energy performance coefficient threshold to EPC 0.4 leads to additional costs of a few thousand euros (NPV) per newly built reference building (table 3.2).

Table 3.2 Investment costs, energy savings and net present values related to adjusting the EPC from 0.6 to 0.4

Building type	Initial investment	Energy savings per year	NPV
Apartment	€ 7,860	€ 246	€ -3,200
Gallery flat	€ 6,520	€ 209	€ -2,700
Mid-terraced	€ 6,460	€ 264	€ -1,800
Semi-detached	€ 11,450	€ 404	€ -4,700
Detached	€ 14,430	€ 457	€ -6,100
Multi-family house*	€ 7,190	€ 228	€ -2,950
Single-family house*	€ 9,353	€ 339	€ -3,410

*Weighted average based on each reference building's share of the total newly constructed residential buildings in 2017 (WoON2018).

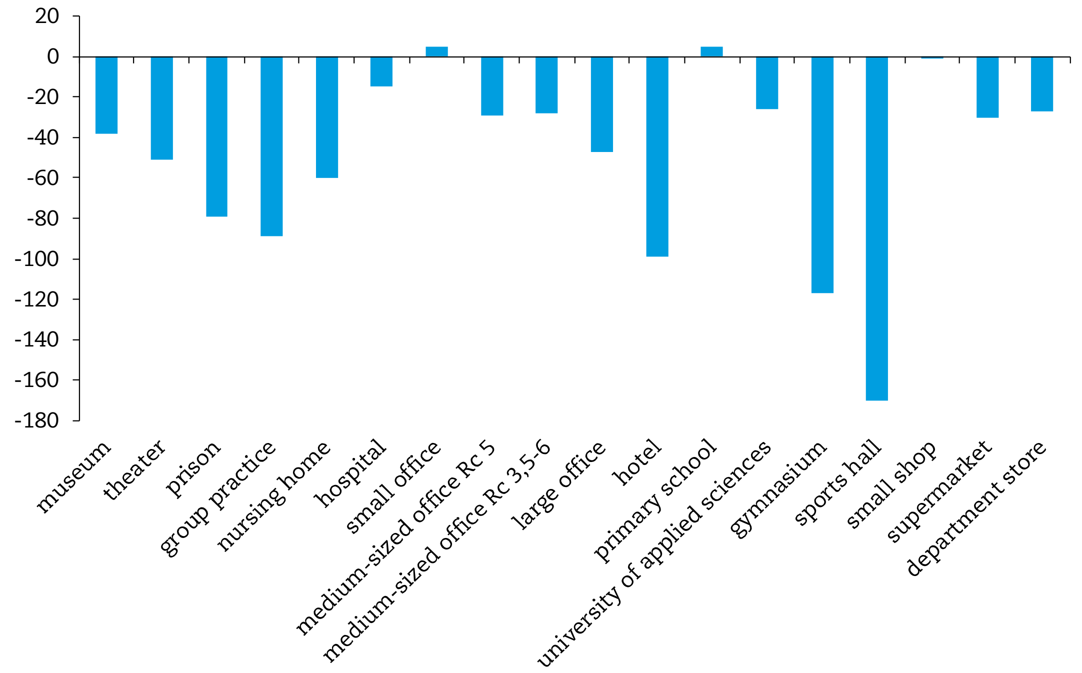
Source: W/E adviseurs & Arcadis, edited by EIB

[119] In order to facilitate the construction sector, the platform 'Very efficient New Buildings' (Zeer Energiezuinige Nieuwbouw) was introduced and preliminary NZEB standards were communicated.

[120] W/E adviseurs en Arcadis (2013), Aanscherpingsstudie EPC woningbouw en utiliteitsbouw 2015.

This conclusion also applies to non-residential buildings, with the exception of small office buildings and primary schools. For the latter two, investments related to complying with the more stringent threshold are still cost-efficient (see figure 3.5).

Figure 3.5 **Net present value of additional investments for non-residential buildings to reach the 2015 energy performance requirements, €/m²**



Source: W/E Adviseurs and Arcadis, edited by EIB

The study by W/E advisory and Arcadis also quantifies the social costs and benefits. Results show that the magnitude of the energy savings and reduced CO_2-emissions (based on the CO_2-prices prescribed by the methodological framework) is approximately equal to the annual running costs. Hence, it can be concluded that even when the reduction in CO_2-emissions is taken into account, the investment costs will not be entirely compensated. The annual CO_2 reduction as a result of the tightening amounts to 43,000 tons for newly built houses. This entails about 0.2% of the total CO_2 emission of the built environment in 2015.

EPC threshold adjustment to 0.4 remains beyond cost-optimal in 2018 review
In 2018 the cost-optimality of the current requirements (EPC 0.4) has been reviewed[121]. This study benchmarks the results of the cost-optimality calculations for various packages of energy saving measures. It should be noted that EPC 0.4 is selected as the reference scenario, which means that there are no additional investment costs attributed to this requirement level and EPC 0.4 is considered as the cost optimal reference. Even though this would lead to net present costs of € 0, there is still a negative cost-benefit balance associated with this EPC-level.

For new residential buildings it can be observed that the cost-optimal points, depending on the reference building, lie approximately between E/E 0.7 and E/E 1.25 (figure 3.6). This can be concluded from the 'lowest' position for each individual reference building, where detached houses have the 'worst' EPC (E/E of 1.25) and corner houses have the best (E/E 0.7). E/E should be

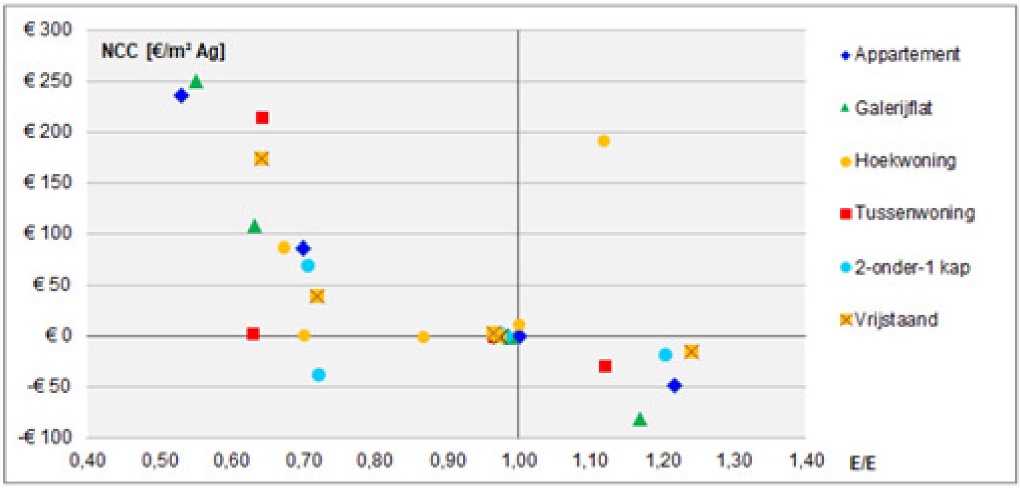
[121] Arcadis (2018), Verslaglegging kostenoptimaliteitsstudie.

interpreted in the same way as Q/Q in the previously discussed study by DGMR Bouw. E/E 0.7 corresponds to an EPC of approximately 0.3, whereas E/E 1.25 corresponds to an EPC of 0.5.

The report concludes that the current requirement of EPC 0.4 lies in the middle of the cost-optimal range. Since corner- and semi-detached houses account for about 20% of the newly constructed domestic buildings, this statement should be interpreted with caution. With the exception of corner houses (E/E of 0.7) and semi-detached houses (E/E of 0.72), the net present costs are lower when the EPC is set at less stringent levels than 0.4; for all types of buildings excluding semi-detached and corner houses, lower net present costs are associated with less stringent levels. Consequently, the current minimum requirements are more ambitious than the cost-optimal level for most new residential buildings[122], meaning that the rise in compliance costs is not sufficiently compensated by the corresponding energy savings.
Especially in the case of multi-family buildings, net present costs would be substantially lower when the EPC threshold is set at a less ambitious level. About 40% of the newly constructed buildings in 2017 comprised multi-family buildings[123]. As such, differentiating the minimum requirements according to the type of building could have led to lower compliance costs.

The conclusion that an EPC of 0.4 is cost optimal is also surprising considering that the energy prices and corresponding benefits of energy savings used in the calculations are substantially lower than the scenario adopted in the preceding cost-optimality assessment of the EPC 0.6 to 0.4 adjustment by W/E advisory. The benefits are relatively higher in this study due to the lower discount rate that has been applied (4.5% instead of 5.5%).

Figure 3.6 Net present cost of energy saving measures for domestic buildings, €/m² useful floor area (Ag)[1]



[1] 1 on x-axis represents EPC 0.4

Source: Arcadis

[122] One interviewee stated that additional costs of €100 per square meter were deemed acceptable in the policy making process.

[123] WoON2018.

Towards NZEB
With the implementation of NZEB, the ambition to further reduce energy consumption is embedded. In this regard it is worthwhile to assess what a further tightening of the EPC would mean. A hypothetical tightening from EPC 0.4 to 0.2 would cause the cost of a new residential building to rise by € 15,000 on average according to construction firms. This rise in costs is twice as large as the increase of costs of the earlier threshold adjustment from 0.6 to 0.4. Of these additional costs, about 75% will not be earned back. This example shows that a further tightening would be cost inefficient and investments would not be earned back.

Due to the obligation to express NZEB buildings in kWh/m² per year, the Netherlands had to let go of the EPC standard and calculation methods were changed, based on the NTA 8800. Furthermore, in 2018 the 'wet VET' was introduced in the Netherlands. This law follows from 'De Energieagenda'[124] and states that changes in regulations are necessary to 'support the energy transition'[125]. The 'wet VET' is formally not linked to the EPBD and states that natural gas boilers cannot be part of new buildings as of July 2018. The introduction of the 'wet VET' and the system change from Energy Performance Coefficient (EPC) to kWh/m² per year as an indicator complicate the comparison of new and old standards, as indicators and calculation methods differ.

In 2019 the cost optimality study was conducted by DGMR[126], which considered cost optimality given the requirement that natural gas could no longer be applied as an energy source. Furthermore, new calculation methods based on NTA 8800 were used with kWh/m² per year as indicators. As a result of the cost optimality studies, the requirements were set at 30 kWh/m² per year in primary energy demand for single family houses and 50 kWh/m² per year for multi-family buildings, which was deemed cost optimal when eliminating natural gas as an option.

The cost optimality study shows that as a result of both NZEB standards and 'wet VET', life cycle costs increase by about € 22,500, of which about half (€ 11,750) will not be earned back[127] [128]compared to current building standards. DGMR and RVO conclude that 5% to 35% of the rise of net life cycle costs is solely attributable to the EPBD[129], equivalent to € 590 to € 4,100 per dwelling. Again, based on 60,000 newly built houses per year, this adds up to € 35,5 million to € 247 million each year, additional to the costs of the tightening of the EPC in 2015. The annual CO_2 reduction as a result of the minimum requirements for NZEB and the wet VET is comparable to the reduction that was achieved through the tightening of EPC 0.6 to EPC 0.4 and amounts to 44,000 tons for 60,000 newly built houses each year. The costs per saved ton of CO_2 as a consequence of both the 'wet VET' and NZEB standards amount to about € 1,000, which is very high compared to other measures[130].

The calculation based on the cost optimality study shows that the step from an EPC of 0.4 in 2015 to 30 or 50 kWh/m² per year is not cost optimal and that that the 'wet VET' is for a large part responsible for the rise in net life cycle costs. Figure 3.7 presents the results of the calculations for different reference buildings as made in the cost optimality assessment for new dwellings[131]. Each colored dot represents a different building type on which energy saving measures are projected. These energy saving measures result in a level of primary energy use (x-axis) and corresponding additional net present costs per square meter (y-axis). Moving to the left along x-axis of the figure means more stringent requirements. As the 'wet VET' is in effect,

[124] Ministerie van Economische Zaken (2016). Energieagenda: Naar een CO_2-arme energievoorziening'.

[125] Wet van 9 april 2018 tot wijziging van de Elektriciteitswet 1998 en van de Gaswet (voorgang energietransitie), Stb. 2018, 109.

[126] Kostenoptimaliteitsstudie NTA8800 Woningbouw en Utiliteitsbouw. DGMR Bouw (2019).

[127] Life cycle costs are initial investments, re-investments and maintenance costs.

[128] Kostenoptimaliteitsstudie NTA8800 Woningbouw en Utiliteitsbouw. DGMR Bouw (2019). Weighted average of the additional initial investment costs, reinvestments and maintenance costs and benefits (energy savings and residual value) of the 20 investment packages with the lowest net present lifecycle costs.

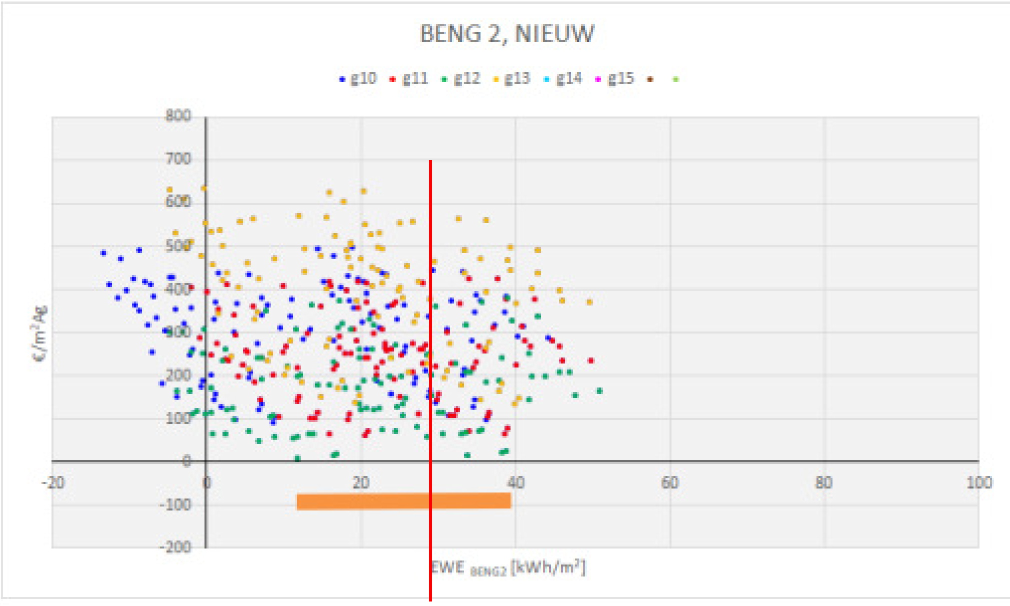
[129] SIRA Consulting (2019) 'Effectmeting wijziging Bouwbesluit 2012'.

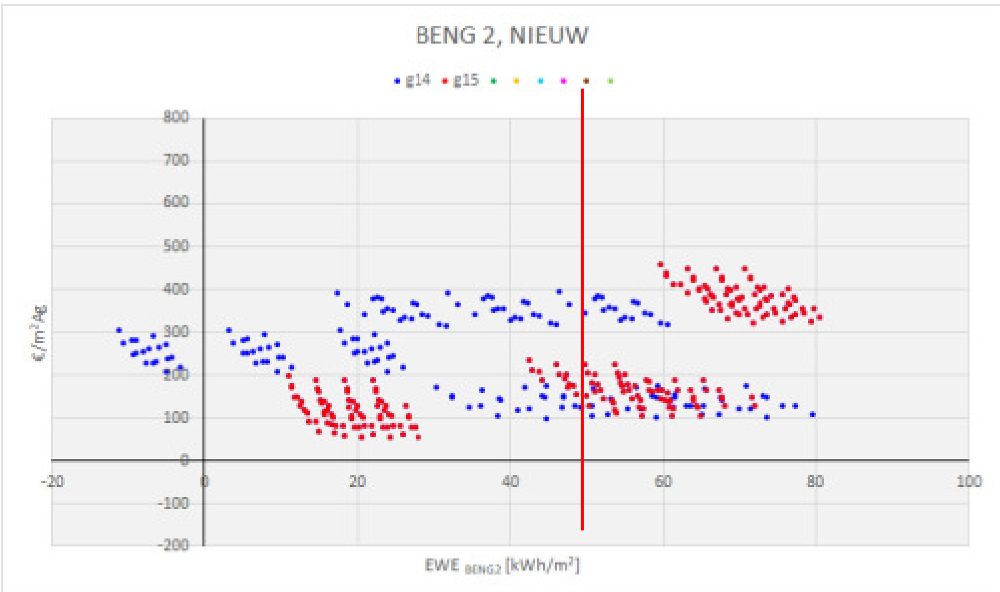
[130] ECN & PBL (2016). Kostenefficiëntie van beleidsmaatregelen ter vermindering van broeikasemissies.

[131] RVO (2019). Advies BENG eisen woningbouw.

solutions using gas boilers are not depicted in the figure. The current standard is set at 30 kWh/m² per year for homes and 50 kWh/m² per year for apartment buildings.

Figure 3.7 Additional net life cycle costs and energy use in kWh/m² per year for different reference houses (above) and apartment buildings (below)[1]





[1] Red line indicates the chosen level of minimum requirements

Source: RVO

From the figure, it can be concluded that there is no cost optimal point. This conclusion is also drawn by RVO in their report. The figure raises a number of questions. Firstly, in earlier researches, a relationship was established between costs and energy use: lower energy use is accompanied by (exponentially) increasing costs, as was concluded with the tightening of the EPC from 0.6 to 0.4 and the (hypothetical) tightening of EPC 0.4 to 0.2. This relationship seems apparent: lowering energy use of an already very energy efficient home is more costly than lowering energy use of an energy inefficient home[132]. This relationship between costs and energy use appears absent in the figure shown, which is notable. Secondly, the use of different sets of measures and various types of buildings explains the broad and indecisive outcomes depicted in figure 1 and makes comparison difficult. Given this situation, it is complicated to attribute costs and benefits to either the 'wet VET' or the EPBD. In this light, the attribution to the EPBD of 5% to 35% of the rise of net costs raises questions. Finally, the data suggest that a differentiation of requirements for different types of houses may be more cost efficient than setting standards for all houses on one hand and all apartments on the other.

The additional benefits of NZEB buildings compared to EPC 0.4 buildings are limited, both when benefits are calculated financial-economically and socio-economically. As additional energy and CO_2 savings from NZEB buildings are small and financial benefits are related to energy savings, results of the economic and social calculations are very similar and net present values are almost identical. Therefore, also from a socio-economic perspective it can be reasoned that tightening of minimum performance standards is not a cost-efficient way to further reduce energy consumption.

When NZEB standards were defined, Portugal defined NZEB beyond financially cost optimal levels and in the Netherlands the combination of NZEB and 'wet VET' is not cost optimal. In contrast, England, Denmark and Germany have maintained the minimum requirements at cost optimal levels for the foreseeable future[133]. The different definitions of NZEB, the choices made in the researched countries and the related (absence of) cost optimality are a direct effect of the discretionary room member states have applied and of national decision making regarding related laws and regulations. The implementations in England, Denmark and Germany have led to less regulatory burden by maintaining cost optimal levels.

The cost optimality of the 'wet VET' itself has not been a subject of (cost optimality) research. Considering the significant increase of the costs of new buildings, probably attributable to the 'wet VET', this is surprising. Furthermore, there are still many investment opportunities in the existing building stock that reduce energy consumption more efficiently. In conclusion, it is recommended that cost benefit analysis is considered standard procedure in regard to energy saving standards in the future. This does not exclude the possibility to consider requirements that are more stringent than cost-efficient levels if so desired, but it does make the impact of measures on regulatory burden more transparent.

From interviews it is gathered that the decision-making process that led to the Dutch definition of NZEB and to tightening to Energy Performance Coefficient (EPC) 0.4 in 2015, was fairly non-transparent. Cost optimality studies concerning the tightening of the EPC-threshold showed that the chosen requirements were not cost optimal. As such, this was known at the time. From expert interviews it can be concluded that stakeholder committees were installed, but that their influence was limited as the desire to adopt more stringent standards was very apparent. More transparency in the decision-making process could lead to a better understanding of the decisions made and increase support for chosen policies.

It has to be taken into account that the calculation methodology causes all-electric concepts, such as heat pumps, to perform better in terms of primary energy demand. This is explained by the application of a lower primary energy factor (PEF) that upgrades the efficiency of electricity generation (see text-box about the PEF below). If a higher PEF value is applied, the NZEB requirements would need to be set at a less stringent level as more primary energy is used.

[132] In economics, this is known as the law of diminishing returns.

[133] Norway, as a non-EU member state, has not defined NZEB levels yet as it aims to learn from the experience of other countries first. In Denmark requirements were set in 2015 at cost-optimal levels. As a consequence of lower energy prices and taxes, however, cost-optimality has been lost in recent years.

Influence of the primary energy factor

The primary energy factor (PEF) is an important parameter when assessing the cost-optimality of minimum requirements. It indicates how much primary energy is needed to generate one unit of final energy. For example, a PEF of 2.5 for electricity implies that the production of one Joule of electricity requires an input of 2.5 Joule of primary energy, which means that power generation has an efficiency of 40%[134]. Adjusting the value of the PEF has direct consequences for the attainable level of minimum energy performance requirements, as these are expressed in primary energy. Lowering the PEF for electricity from 2.56 to 1.45, as has been the case in the transition towards the NTA 8800, means that lower levels of primary energy demand can be reached without taking additional measures in the building. When such a downward adjustment occurs without further strengthening of the minimum requirements, this will shift the requirements more towards the cost-optimal level as less fossil energy needs to be compensated through, for example, additional insulation. Moreover, decarbonizing electricity generation will make all-electric solutions more energy efficient compared to alternatives based on fossil fuels. Hence, investments that raise the share of renewable resources in electricity generation and secure sufficient electricity supply may be a more efficient trajectory with respect to creating a more energy efficient built environment. The benefits of such an approach will be more widespread as it not only reduces the primary energy demand of new buildings, but also of existing buildings (although it should be noted that the effects for existing buildings that make use of fossil-based solutions are smaller). Consequently, it can be argued that the cost-optimality assessment procedure should incorporate investments in energy infrastructure as well.

In order to pursue the goal of the EPBD, which is a more energy efficient built environment, it is important that a realistic value of the PEF is adopted. An underestimation of the efficiency of electricity generation will lead to unnecessary and expensive investments at the building level, whereas an overestimation may result in insufficient primary energy savings. As the PEF has been set at the level of 2.56 in 1995, it is deemed reasonable to assume that today's efficiency of electricity generation is higher. However, concerns have been raised about setting the PEF to 1.45 by 2020. Critics argue that this level will not be reached until 2030 and mention that a value of around 2,0 would be more appropriate[135]. On the contrary, it is important to consider the development of the PEF over time, as not considering further improvement of the efficiency of electricity generation will lead to unnecessary investments at the building level.

3.3.1 Regulatory burden: expected versus actual

As outlined before, the expected regulatory burden with respect to minimum energy performance requirements has been quantified in advance of the EPBD 2010 implementation[136]. This study provides an estimation of the additional administrative costs to businesses, building owners and the government. The regulatory burden is attributed to either one-off costs or structural costs incurred each year. According to this study, there are no specific one-off administrative costs related to adjusting minimum requirements for new buildings, major renovations or building components and technical building systems. It is unclear whether part of the familiarization costs that are contained in the category labelled 'remaining costs' are attributed to businesses that have to familiarize with adaptations to building regulations. However, it is mentioned that with respect to the calculation of these costs it is assumed that businesses spend half an hour on average on familiarization. Considering that in 2010 there were around 52,000 construction companies operating in the residential and non-residential

[134] https://www.eurelectric.org/media/2382/2018_industry_association_position_on_pef_revision-2018-030-0114-01-e-h-216CBE01.pdf.

[135] https://fd.nl/opinie/1321344/plan-minister-ollongren-leidt-tot-meer-kosten-en-CO_2-uitstoot, https://www.bouwtotaal.nl/2019/10/kritiek-op-beng-eisen-houdt-aan/ en https://www.isover.nl/nieuws/hoe-erg-het-nou-eigenlijk-die-nieuwe-beng-norm.

[136] SIRA consulting (2010), Gevolgen administratieve en uitvoeringslasten herziene EPBDr.

building sector[137] that needed to familiarize with adaptations to the building decree, this implies one-off costs amounting to approximately € 1.4 million. Moreover, structural costs related to the minimum requirements are limited to compliance costs and as such not incorporated. Hence, the initially estimated regulatory burden is about €1.4 million.

Based on the actual costs that relate to tighter EPC requirements, it can be concluded that initially expected one-off and structural costs have been underestimated. In practice, the one-off costs related to familiarization with adjusted building regulations were much higher. During the interview sessions it has been pointed out that taking notice of and adapting to new EPC requirements takes at least a day. Based on 52,000 construction companies and an hourly rate of € 45 for familiarization, the one-off costs related to the first adjustments amounted to € 18.5 million in 2010. The adjustment in 2015 led to a cost of about € 21 million, based on the same tariff and about 58,000 companies.

With respect to the proportionality of the compliance costs related to tighter EPC requirements, it can be concluded that the additional investments of the first adjustment (to EPC 0.6) were fully compensated by benefits in terms of a lower energy bill. In contrast, the second tightening of the EPC threshold has not been able to deliver sufficient energy savings to balance out the rise in investment costs. According to the cost-optimal level assessment by W/E adviseurs and Arcadis the future energy savings of setting the EPC-threshold to 0.4 cover between a third and two thirds of the investments that are needed to reach this level of energy efficiency, dependent on the building type. In interpreting these numbers, it has to be taken into account that actual and calculated energy savings can differ. In practice, energy savings tend to be overestimated in houses with higher energy classes, which might mean that less than a third to two thirds of the investment will be covered by energy savings.

No studies have been conducted regarding the actual versus expected increase in building costs as consequence of the EPBD implementations. As these studies are conducted by engineers using current building costs, which are generally well documented, a deviation between expected and actual costs is not expected. Furthermore, the tightening of the EPC requirement from 0.6 to 0.4 does not necessitate using ‘unproven’ techniques for which cost estimates can be uncertain. Therefore, it is expected that actual and estimated construction costs generally have been the same.

3.4 What are the experiences with the legislation in practice?

Based on interviews with stakeholders it has not been a problem for the construction industry to comply with the tighter EPC-requirements. Initially, developers found smart solutions that boosted the EPC rating without radically changing the building envelope. For example, compliance with the building regulations could be reached by placing a single solar PV panel on the roof of particular residential homes, whereas no additional insulation was applied. At the end of the line this has little effect on the energy consumption and consequently the requirements for components of the building envelope were tightened to ensure a certain level of insulation would be applied.

Corporations and private landlords of social houses have been faced with substantial costs in relation to the different systems for new and existing buildings. After a new property is constructed, they are required to obtain an expert energy performance certificate before they can let the property. Considering that the energy performance of new buildings is known as an EPC is calculated, this is perceived undesirable as it leads to unnecessary additional costs.

The European methodological framework by which the energy performance for nearly zero-energy buildings is to be calculated, leaves the developers of the NTA 8800, software developers, building companies and other stakeholders that use it in practice with a very short familiarization period. Considering that the building permit application procedure takes at least a couple months and buildings are required to conform to the NZEB standards by January 2021,

[137] CBS statline.

the software would need to be ready well in advance. Although some developers have released early versions of the software that calculates the energy performance in accordance with the NTA 8800 during the first half of 2020, the software is still under development. Different stakeholders have mentioned that this will probably lead to delays in the realization of new buildings and higher costs. Moreover, the interference between minimum energy performance requirements and national requirements concerning the environmental performance of buildings (Milieu Prestatie Gebouwen (MPG)) especially leads to complications with respect to the design and as such further increases regulatory burden.

Consequences of the split incentive for investments in social housing

For energy efficiency investments in owner-occupied homes the benefits related to the investment accrue to the owner of the building. This provides owners an incentive to improve the energy efficiency of their home, as long as the benefits outweigh the costs. In case of rental properties, this incentive is absent as the benefits accrue to the tenant, whereas the investment is made by the owner. Benefits can be (partially) reallocated to the property owner by raising the rental price. However, this is not always a possibility. Especially social housing corporations encounter a problem in appropriating benefits, as they are bound to a rent that is lower than the 'liberalization-limit' of around € 700. Considering that there is a maximum rental price that can be charged for social housing, the ability to raise the rent in relation to energy efficiency improvements is limited. As such, more stringent minimum energy performance requirements result in additional costs for social housing corporations, which cannot be fully passed on to tenants.

3.5 Implementation across countries

Similar to the Netherlands, other countries have implemented the EPBD requirement to set minimum energy performance standards for new buildings, major renovations and building components within existing legislation. As such, local authorities are usually charged with the responsibility of checking compliance with the building regulations. However, in England and Portugal, compliance checks can also be delegated to private building inspectors. In practice, interviews with stakeholders in the different countries revealed that safety is generally considered more important and as a consequence less time is spent on checking compliance with minimum energy performance requirements. Especially in England, where according to the interviewees local authorities are understaffed, it can be questioned whether new buildings meet the standards once constructed[138].

The minimum requirements at the building level vary significantly across countries. Table 3.3 presents the requirements that relate to the energy performance of the overall building[139]. It can be observed that with the exception of the Netherlands, the requirements are generally more strict for multi-family buildings than for single-family houses. Moreover, the most stringent requirements for single-family houses are found in the Netherlands.

[138] This is particularly the case for smaller builders as large developers generally do not risk the reputational damage of not complying with buildings regulations.

[139] For the Netherlands, NZEB requirements are given for comparison.

Table 3.3 **Current energy performance requirements for residential buildings, expressed as primary energy demand (kWh/m²/year)**

	Denmark	England	Germany	Netherlands	Norway*	Portugal
Single-family house	33.5-40.9	93	34.7-56.9	30	100 + 1.600/m² HFA**	NA
Multi-family building	33.5-34.7	92	31-33.2	50	95	NA

* In Norway all electricity is based on renewable energy sources. Gas boilers are not allowed to be used in new buildings and therefore the primary energy demand is zero. As such, the requirements are expressed in terms of delivered energy.
** Heated Floor Area.

Source: Concerted Action

The variation with respect to additional requirements for individual parts of the building envelope seems limited (table 3.4). This can be explained by the fact that the limits set for these components ensure a level of thermal insulation that is deemed desirable both from an indoor climate and energy performance perspective. These levels are generally not stringent enough to reach compliance with the energy performance requirements at the building level. This provides developers with sufficient degrees of freedom with respect to the design, while guaranteeing that a sufficient level insulation is applied.

Table 3.4 **Current minimum energy performance requirements for fabric elements in new buildings, maximum U-values**

	Denmark	England	Germany	Netherlands	Norway	Portugal
Walls	0.25	0.2 - 0.3	0.28	0.22	0.18 - 0.22	0.35 - 0.5
Floors	0.3	0.2	0.35	0.29	0.1 - 0.18	0.3 - 0.4
Roofs	0.2	0.25	0.2	0.17	0.13 - 0.18	0.3 - 0.4
Windows, doors and joints	1.35	2.0	1.5	1.65	1.2	2.2 - 2.8

Source: Concerted Action

NZEB only defined in the Netherlands and Denmark
At this point, Denmark and the Netherlands are the only countries that have defined the NZEB level, which explains the stringent levels in these countries depicted in table 3.3. In the case of Denmark, the NZEB level was already defined in 2008 and initially set at an even more ambitious level. Changes of the Danish building regulations are preceded by a two-year introduction period during which the future requirements are introduced as a voluntary standard. This enables the government to evaluate whether the requirements are feasible before making them mandatory. Throughout this introduction period, it became clear that the initially specified NZEB level could not be reached cost-efficiently. Consequently, the Danish government decided to adapt the NZEB definition in accordance with the 2015 requirements that were found to be cost-optimal.

Norway not bound to regulations, England aims for implementation in 2025
The interviews with stakeholders in the remaining countries revealed that they experience difficulty with respect to defining the NZEB standards at a cost-optimal level, which has delayed the process. Norway has not formally implemented the EPBD 2010 and as such takes the opportunity to learn from the experiences in EU member states. In England the NZEB level was more or less specified in 2006 as the zero-carbon standard. However, the ambitions have eroded over time as a result of political considerations. The current level was still found to be cost-optimal and as such does not require further tightening. Consequently, the current level of requirements is not particularly ambitious compared to the other countries. The so-called future home standard, which will represent the NZEB level, is currently under development and will likely be implemented by 2025.

Germany considers 2016 standard as NZEB, leading to cost optimality
In Germany, the NZEB level is determined based on regular cost-optimality studies. As such the cost-optimal level of 2016 is set as the NZEB standard until at least 2023 when the costs of more stringent requirements will be reviewed on cost-optimality again. From interviews it has also become clear that industry lobby has led to a definition of NZEB where no industries or types of systems are excluded. Nevertheless, the requirements for multi-family buildings are more stringent compared to the other countries. This can be explained by the use of a lower PEF (1.8) than the other countries (with the exception of the Netherlands), which leads to lower primary energy use for the same set of measures.

Portugal: cost optimality acquired through incorporation of social benefits
Finally, in Portugal the NZEB level is specified as an improvement of 25% compared to the current requirement, which is an overall energy rating of B- at the national level. It is not sufficiently clear how this translates to the primary energy demand in $kWh/m^2/year$, but based on the interviews it can be concluded that this level is very ambitious and as such not cost-optimal from a financial perspective. However, from a social perspective they argue that this level is cost-optimal because factors such as living comfort are considered.

Denmark uses discretionary room to limit burden in case of renovations
With respect to the definition of major renovations, most countries have adopted the option that defines major renovations as at least 25% of the building envelope as this is generally easier to determine than defining major renovations as 25% of the value of the building and thereby limits regulatory burden. Only in Denmark a different route has been taken. The definition of major renovations as prescribed by the EPBD has not been implemented. Instead, Denmark has chosen to set requirements for individual building components that are subject to renovation (Appendix D, table D.4). However, when you can prove that the required level is not cost-optimal, a building owner is not required to execute this measure. This could be the case when a building owner wants to renovate a roof, which already has 250 mm insulation whereas the requirement is 300 mm. In the case of a full replacement of a component, the requirements will have to be met even when the measure is not cost-effective.

3.6 Comparing cost-optimal level assessments

As outlined in the previous section, the levels of minimum requirements vary significantly across countries. This variation is interesting considering that the same methodological framework is applied to determine the cost-optimal levels. In order to understand the underlying reasons for the deviation, it is important to identify what factors can affect the outcomes of the cost-optimal levels assessment. First of all, physical building characteristics influence the cost-optimal level. As such, the use of different reference buildings between countries may lead to different outcomes. Secondly, climate is accounted for within the methodological framework giving rise to varying cost-optimal levels across different climatic zones. Another important factor that influences the outcomes of the cost-optimal level assessments relates to the investment costs and development of energy prices adopted in the calculations. Furthermore, the discount rate has an impact on the outcomes although sensitivity analyses show that applying various discount rates does not alter the cost-optimal level to a large extent. Finally, the value selected for the primary energy factor affects the energy performance outcomes as a more favorable primary energy factor will allow countries to find cost-optimal solutions at lower levels of primary energy demand.

An overview of the discount rates and the PEF used in four countries is given in table 3.5. Studies of Portugal and Norway were not available in English and have not been included in the table. Relatively high discount rates result in relatively low future benefits and hence lower net present values of investments compared to other countries.

Table 3.5 Inputs used in the cost-optimal levels assessments of 2018

	Denmark	England	Germany	Netherlands
Financial discount rate	Residential: 0.7% Non-residential: 1.0%	Residential: 6% Non-residential: 6%	Residential: 0% Non-residential: 0%	Residential: 4.5% Non-residential: 7.0%
Social discount rate	3%	3.5%	NA	3%
PEF	2.31	2.364	1.8	2.56

Source: Cost-optimality assessments commissioned by the EC

Apart from the aforementioned parameters, different interpretations of cost-optimality can lead to different cost-optimal levels. The methodology prescribes the determination of a cost-optimal range within which the requirements should be set. As such, selecting a point at the lower bound or at the upper bound of this range can make a large difference with respect to the level of the energy performance requirements and accompanying costs. Because the range is determined as a 15% deviation from the cost-optimal point, this implies that countries that identify their cost-optimal point at higher levels of primary energy demand have a larger cost-optimal range. The next paragraphs will demonstrate how the interpretation of the cost-optimal levels and ranges affects the minimum energy performance requirements in the evaluated countries that have specified requirements at the building level[140].

Denmark sets ambitious minimum requirements

In Denmark the cost-optimal levels are determined for the following residential reference buildings: single-family houses with district heating, single-family houses with heat pumps and multi-family houses with district heating. As a consequence, different levels of minimum requirements and cost-optimal levels are specified according to the heating system that is in place. Moreover, the minimum requirements consider whether solar PV is applied to the reference building. Table 3.6 presents the current minimum requirements and the cost-optimal levels and ranges for each of the reference buildings. It becomes clear that the current requirements are more ambitious than the cost-optimal levels and are located outside the cost-optimal range (with the exception of the requirements set for multi-family houses that use solar PV). However, the interview sessions in Denmark have learned that these requirements were (close to) cost-optimal back in 2015. As a result of decreasing energy prices and taxes between 2015 and 2018, cost optimality no longer applies.

[140] Norway is not included because they are not required to use the cost-optimal methodology to report to the EU and they have not specified their energy performance requirements in terms of primary energy demand. Portugal is not included as they have only specified energy performance requirements for individual building elements.

Table 3.6 Current requirements compared to cost-optimal levels and ranges in Denmark, kWh/m²/year

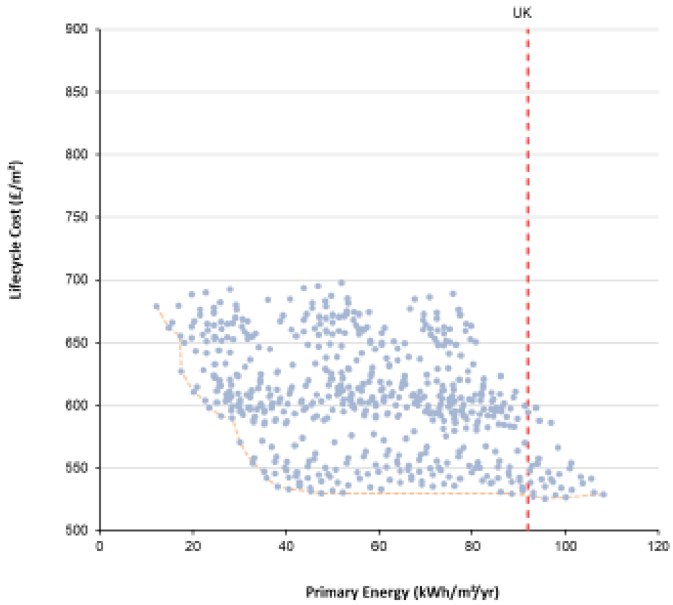
	Single-family house with district heating	Single-family house with heat pump	Multi-family house with district heating
Current requirement excluding PV	40.9	33.5	33.5
Current requirement including PV	35.5	NA	34.7
Cost optimal level	58.7	46.1	39,9
Cost-optimal range	49.9 – 67.5	39.2 – 53.0	33.9 – 45.9
Requirement within cost-optimal range	No	No	Only including PV

Source: Cost-optimality of Danish minimum requirements 2018, edited by EIB

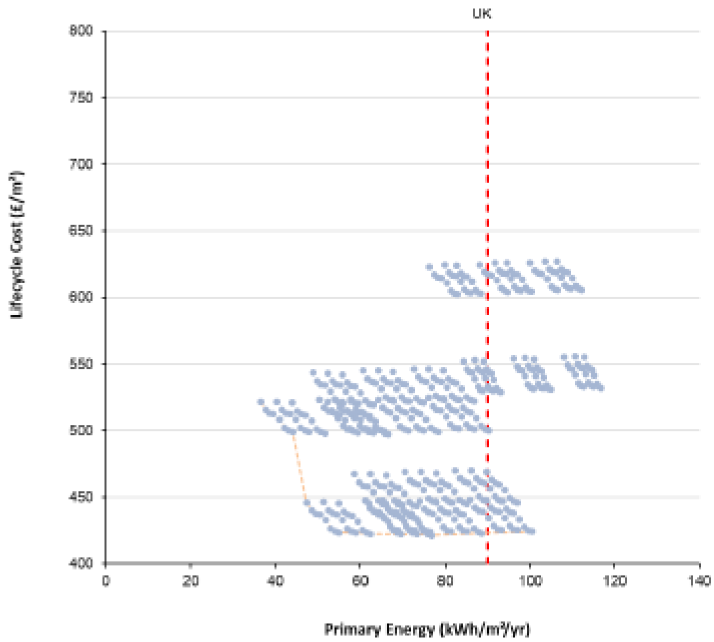
England actively pursues discretionary room with respect to the minimum requirements
In England the cost-optimal levels are determined for the following types of residential reference buildings: semi-detached houses and apartment blocks. As can be seen from figure 3.8, there are many sets of measures that have similar results in terms of lifecycle costs. Consequently, England could have benchmarked their current requirements against various cost-optimal levels. The cost-optimal points that were adopted lie near the upper bound of this range (96 kWh/m²/year for semi-detached houses and 77 kWh/m²/year for apartment blocks). Hence, the requirement for semi-detached houses is located below the identified cost-optimal level (table 3.7). However, when a more stringent cost-optimal level is adopted the current requirement would be less ambitious than the cost-optimal level. For apartment blocks the current requirement deviates more than 15% from the cost-optimal level.

Figure 3.8 Cost-optimal levels United Kingdom for semi-detached houses and apartment blocks, macroeconomic calculation

Semi-detached house



Apartment block



Source: Second Cost-Optimal Assessment for the United Kingdom, 2018

Table 3.7 **Current requirements compared to cost-optimal levels and ranges in England, kWh/m²/year**

	Semi-detached house	Apartment building
Current requirement	93	92
Cost optimal level	96	77
Cost-optimal range	81.6 – 110.4	65.5 – 88.6
Requirement within cost-optimal range	Yes	No

Source: Second Cost-Optimal Assessment for the UK, edited by EIB

Germany lets 'technique neutrality' prevail when setting minimum requirements
In Germany the cost-optimal levels are determined for seven residential reference buildings. For all these types of buildings the requirements are less ambitious than the cost-optimal level (table 3.8). Only for small-single-family houses with a basement and semi-detached houses the requirements fall within the 15% allowed range. The reason why the requirements are not further tightened to the cost-optimal level is the focus on technique neutrality as cost-optimal levels can only be attained by solutions that make use of a heat pump. This shows that room for discretion is pursued and granted by the EU. Furthermore, the low PEF used makes tight requirements relatively easy to reach.

Table 3.8 **Current requirements compared to cost-optimal levels and ranges in Germany, kWh/m²/year**

	Small-single-family house with basement	Small single-family house without basement	Large single-family house with basement	Semi-detached house	Mid-terraced house	Small multi-family house	Large multi-family house
Current requirement	38.0	56.9	34.7	50.3	35.5	33.2	31.0
Cost optimal level	34.5	47.4	29.9	45.8	30.7	27.9	26.9
Cost-optimal range	29.3 – 39.7	40.3 – 54.5	25.4 – 34.4	38.9 – 52.7	26.1 – 35.3	23.7 – 32.1	22.9 – 30.9
Requirement within cost-optimal range	Yes	No	No	Yes	No	No	No

Source: German cost-optimal level assessment, edited by EIB

The Netherlands could have set less ambitious minimum requirements
In the Netherlands the cost-optimal levels are determined for six residential reference buildings. However, the requirements are not differentiated according to the type of building. When the cost-optimal ranges are identified for each individual reference building, it becomes clear that an EPC of 0.4 only lies within this range for mid-terraced houses and gallery apartments (table 3.9). For semi-detached and corner houses, tighter EPC requirements were possible. Except for semi-detached houses and corner houses the current requirement is set near the lower bound of the cost-optimal range, indicating that room for discretion could have been used to set the requirement somewhere between EPC 0.5 and 0.6.

Table 3.9 Current requirements compared to cost-optimal levels and ranges in the Netherlands, Energy Performance Coefficients

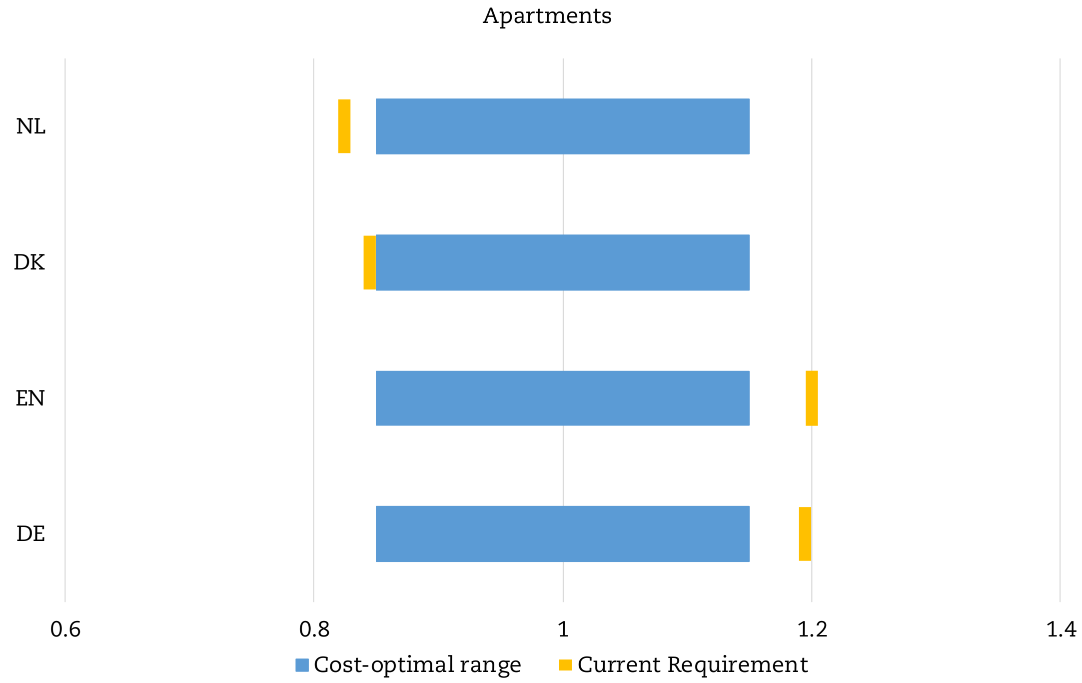
	Corner house	Mid-terraced house	Semi-detached house	Detached house	Apartment	Gallery apartment
Current requirement	0.4	0.4	0.4	0.4	0.4	0.4
Cost optimal level	0.28	0.45	0.29	0.5	0.49	0.47
Cost-optimal range	0.24 – 0.32	0.38 – 0.52	0.24 – 0.33	0.42 – 0.57	0.41 – 0.56	0.4 – 0.54
Requirement within cost-optimal range	No	Yes	No	No	No	Yes

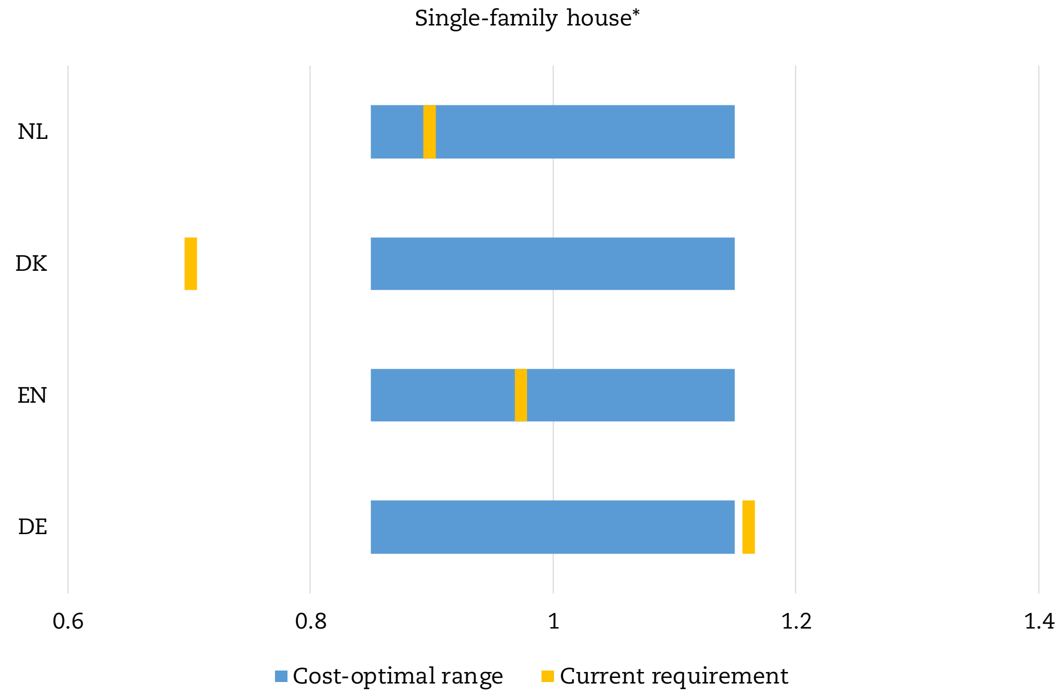
Source: Arcadis, edited by EIB

Location of the requirements relative to the cost-optimal range
Figure 3.9 provides a graphical representation of where the requirements are located relative to the cost-optimal level. For apartments, the Netherlands and Denmark have set their requirements more than 15% beyond cost-optimal[141], whereas England and Germany have requirements that deviate approximately 20% from the cost-optimal level at the other end of the spectrum. With respect to the single-family houses, Denmark has set its requirements far beyond the cost-optimal level. The Netherlands and England have set their requirements below the cost-optimal level, but within the 15% range. For Germany the requirement level is located just above the upper bound of the cost-optimal range. These results indicate that if the Netherlands had adopted a similar approach as England and Germany, the requirements would have been less stringent and cost optimal for building owners.

[141] In Denmark, cost optimality was ensured in 2015 when setting the standard. Due to lower taxes and lower energy prices, cost optimality is lost in the most recent cost optimality assessments.

Figure 3.9 Minimum energy performance requirements relative to the cost-optimal range





* Within this category countries have adopted different reference buildings. In order to make a comparison, this figure represents the reference building per country that is the most similar to a mid-terraced house.

Source: Cost optimality reports, edited by EIB

3.7 Conclusions and recommendations

Initially, tightening of the energy performance coefficient thresholds in the Netherlands was in line with the cost-optimal levels. However, the further adjustments of the threshold that entered into force in 2015 have only been partially compensated by lower energy bills (and CO_2-emissions). Moreover, the gap will become even larger when aligning the threshold with the NZEB standard. By letting go of the principle to set minimum requirements at cost-optimal levels, the proportionality of the regulatory burden can no longer be guaranteed and costs clearly outweigh both financial and social benefits.

Based on the comparison of minimum energy performance requirements across countries, it can be concluded that considerable room for discretion exists and is actively pursued. Some countries have decided to set the requirements at the lower end of the cost-optimal range (Denmark and the Netherlands), whereas other countries have adopted levels that are less ambitious than the cost-optimal point (England and Germany). As the NZEB level does not need to exceed the cost-optimal level, the definition adopted by the Netherlands is considered to be rather ambitious with regards to costs incurred. The regulatory burden could have been limited if a different perspective on cost-optimality would have been pursued. A consequence of this approach is that proportionality of the energy saving measures is no longer guaranteed. Moreover, additional policies such as prohibiting the use of gas boilers have contributed to setting stringent energy performance requirements as not all cost-optimal alternatives are considered as a consequence.

The goal of the EPBD is to reduce CO_2 emissions within the built environment and consequently it could be argued that there are different trajectories to pursue this goal. Because new buildings are already very energy efficient, it can be questioned whether it makes sense to further improve the energy performance of the new building stock under the current cost inefficient circumstances. Considering that there are still many cost optimal investment opportunities in the existing building stock that reduce energy consumption more efficiently, it might be worth exploring these opportunities in more detail.

Another important implication of the cost-optimal level assessments is the fact that the methodology only takes the energy efficiency of the building itself into account. For example, decarbonizing electricity production might be a more efficient way to realize a lower primary energy consumption. Additionally, the benefits of such investments are not limited to new buildings. Therefore, it can be recommended to incorporate investments in energy infrastructure in the methodological framework that is used to determine cost-optimal levels.

4 Inspection of technical building systems

4.1 What does the directive prescribe?

The 2002 directive prescribes that boilers with an effective rated output for space heating purposes of more than 20 kW, fired by non-renewable liquid or solid fuel, and air-conditioning systems of an effective rated output of more than 12 kW must be regularly checked. Boilers with an effective rated output of more than 100 kW must be checked at least every two years. This may be extended to every four years for gas boilers. Heating systems with an effective rated output larger than 20 kW and older than 15 years must additionally be inspected once. The inspection must include an assessment of the efficiency of the system and the sizing compared to the heating requirements of the building and can include an advice for replacement or alternative solutions. The directive also prescribed that the inspections must be carried out in an independent manner and by qualified and/or accredited experts.

In 2010 the requirement for an inspection of boilers was extended to all accessible parts of systems used for heating buildings, such as heat generators and circulation pumps. Also, it was added that with the inspections of heating and air-conditioning, a report must handed over to the owner or tenant of the building that includes the result of the inspection and the recommendations of cost-effective improvements. The requirement for a one-off inspection of heating systems older than 15 years was cancelled with the EPBD of 2010. The EPBD of 2010 also gives member states the option not to require the assessment of the sizing of the systems to be repeated as part of the inspection in case no changes have been made following an earlier inspection.

In 2018, the directive states that the requirements regarding the inspection of heating and air-conditioning systems have not been efficient because 'they did not sufficiently ensure the initial and continued performance of those technical systems'. Presumably since regulations were not efficient, the directive becomes less stringent by prescribing inspections for heating and air-conditioning systems with a higher effective rated output than 70 kW (instead of respectively 20 kW and 12 kW in the EPBD 2010), so inefficient inspections are avoided. Technical building systems that are explicitly covered by contractual agreements regarding energy performance are exempt from the requirement to be inspected on a regular basis.

The EPBD III prescribes that for systems larger than 290 kW an automated system that meets the specific requirements of the EPBD is required from 2026. Generally, the installation of automation and control systems is promoted and these buildings are exempt from the requirement to inspect the installations.

4.1.1 In what areas does the directive provide member states with room for discretion?

The directive does not prescribe how often the inspections for boilers with a lower effective rated output than 100 kW or air-conditioning systems must take place. Member states therefore have discretion to establish the frequency with which inspections must be held. The directive of 2002 gave member states the option to opt for an alternative system for boilers which would also include an assessment and an advice to the users and would broadly have an equivalent overall impact as inspections. Member states are expected to report on the equivalence of their inspection system to the European Commission. The directive of 2010 also allowed member states to implement an alternative system for air-conditioning systems, as was allowed for heating systems from 2002.

4.2 How is the directive implemented into national legislation in the Netherlands?

The Netherlands firstly only implemented inspections for boilers larger than 20 kW fired by non-renewable liquid or solid fuel and gas-fired boilers of more than 100 kW, as part of the

“Activities Decree Environment Management” (Activiteitenbesluit Milieubeheer). After remarks from the EU, the mandatory inspection of air-conditioning systems with an effective rated output of more than 12 kW was put in place once every five years as part of the “Decree on Energy Performance of Buildings” (Besluit Energieprestatie Gebouwen (BEG)) from April 2009. As a consequence of the EPBD of 2010, voluntary inspections were introduced for gas-fired boilers with an effective rated output of 20-100 kW. Table 4.1 shows how the directive is currently implemented in Dutch national legislation for heating systems depending on the effective rated output and the type of fuel.

The Regulation on Energy Performance of Buildings (“Regeling Energieprestatie Gebouwen”(REG)) prescribes that the air-conditioning inspections must be performed by a certified expert. For installations below 45 kW, an EPBD-A diploma is required. From 45 kW, an EPBD-A inspector may collect the necessary information while the report and recommendations must be formulated by an EPBD-B inspector. Inspection of larger systems thus must be conducted by both an EPBD-A and -B inspector or a person who is in possession of both qualifications.

As only voluntary inspections were introduced for gas-fired heating systems with an effective rate output of 20-100 kW, the only effect of the EPBD of 2010 in the Netherlands that affected regulatory burden has been the requirement that a report must be made at the inspection of air-conditioning systems which was included in the Decree in 2013.

Table 4.1 Requirements for inspection of heating systems in the Netherlands

	Effective rated output		
	≤ 20 kW	20 – 100 kW	≥ 100 kW
Gas-fired	Voluntary	Voluntary	Every 4 years
Solid/fluid		Every 4 years	Every 2 years

Source: Netherlands Enterprise Agency (RVO)

Implementation of EPBD 2018

The new amendments to the EPBD from 2018 reduce the amount of inspections of air-conditioning systems as the minimum effective rated output is increased to 70 kW. For heating systems, inspections are now also only required for all systems with an effective rated output of at least 70 kW. The different directives for different fuels have been cancelled. In the Netherlands, this leads to a reduction in regulatory burden as solid or fluid fired systems with an output of 20-70 kW no longer need to be inspected. However, gas-fired systems with an output of between 70 and 100 kW are required to be inspected regularly. It is not clear what the net effect of these changes is on regulatory burden.

In Dutch legislation the requirement for inspections of heating and air-conditioning systems was implemented as of March 10, 2020 in the Dutch Building Decree (Bouwbesluit 2012). As a result, the authorities responsible for control on the Dutch Building Decree, in many cases local municipalities or the delegated regional “Environment Services” (Omgevingsdiensten), are now also responsible for the compliance of the inspections. This shift of responsibility for the control on the inspection of the heating and air-conditioning systems is expected to reduce (potential) costs of the control system as the enforcement of the inspection scheme of installations can be combined with the enforcement of other legislation. However, it might also lead to different approaches between municipalities and regions[142].

[142] The fact that these different approaches occur in practice became clear from interviews on experiences in Germany.

4.2.1 What control system is in place?

The Regulation on Energy Performance of Buildings prescribes the requirements set for independent experts that perform the inspections on air-conditioning systems. There are several organizations made responsible for the examination of potential experts and the development of programs that improve the knowledge of experts on a regular basis. Some of these have also initiated a certification of businesses that perform the inspections on their own accord. The Human Environment & Transport Inspectorate (ILT) is responsible for the enforcement of inspections and the presence of inspection reports.

For boilers and other heating systems, SCIOS certifies companies that perform the inspections and performs quality control to ensure inspections are done in the prescribed way.

4.2.2 Expected regulatory burden

A study from 2010[143] concluded that the initial costs as a result of the EPBD requirements regarding boilers and heating systems with an effective rated output lower than 100 kW would amount to nearly € 6 million, while the yearly costs for building owners would be larger. The expected regulatory burden of air-conditioning systems has not been included in ex-ante studies.

4.3 What are the experiences with the legislation in practice?

In practice, this part of the EPBD brings about costs for, mainly, commercial owners of buildings as inspections for smaller heating and air-conditioning systems are kept voluntary. The inspections and the accompanied reports are similar to energy performance certificates in the sense that they provide information on how the energy performance may be improved. The inspection itself, however, does not lead to any energy efficiency improvements. In essence, it is assumed that the providence of information would lead to building owners or tenants taking measures with which the energy performance of the system is improved. There is, however, no evidence available of this occurring in practice.

Although the inspections and reports are a consequence of the European requirement following from the EPBD, the Netherlands could have looked at alternative, more efficient ways of implementing this requirement which could have led to more energy consumption reduction. Consequence of the current system and lack of effect on the energy efficiency of installations in practice is that inspections are downsized to another administrative requirement with hardly any effect on the actual energy consumption of buildings.

Experts bring forward that (parts of) the inspections may already be part of regular checks that are taken for safety reasons and that different inspections possibly can be combined for efficiency gains. They state that especially the extra requirement of having to issue an inspection report does not bring about any additional effects on energy consumption, while it does lead to extra costs. For these reasons, the Inspectorate does not enforce the periodic inspections and presence of the inspection reports: it would be labor-intensive while the benefits are deemed limited. This lack of enforcement is an indication of choices made in the consideration between regulatory burden and potential benefits in practice. Following the implementation of EPBD III, the aforementioned shift of responsibility might lead to different methods of enforcement and a higher compliance rate.

4.4 Regulatory burden and benefits in practice

It can be concluded that the Netherlands have implemented the requirement of the EPBD quite efficiently. As a consequence of the EPBD of 2010, the Netherlands have only introduced voluntary inspections for smaller gas-fired heating systems. As these were already widely used by households, the Netherlands was able to show that regular maintenance meets the

[143] SIRA Consulting (2010), Gevolgen administratie en uitvoeringslasten herziene EPBDr.

requirements of the directive. This has greatly limited regulatory burden for households and commercial home owners. As these inspections are voluntary and were already a custom before implementation of the EPBD, there is no effect on regulatory burden. Therefore, in this paragraph only the regulatory burden of air-conditioning systems is presented.

Table 4.2 gives an overview of the regulatory burden from the inspection of air-conditioning systems as a consequence of the EPBD. Though only inspection reports were introduced in the Netherlands as a consequence of the EPBD 2010, the table shows the costs of the entire system as it is known today for the sake of integrality. The time investment is the actual time spent performing an activity, based on an hourly tariff of € 34 for technicians and € 54 for highly educated employees. Cost per one are costs for individual courses or exams for inspectors or acquiring inspections for buildings owners. The costs are shown in the case of full-compliance, when all buildings owners would comply with the requirements. As described above, because of the lacking control system, inspections occur a lot less frequently in practice. Therefore, in practice, the costs will be much lower than shown in table 4.2. However, in policy making and when considering alternatives, regulatory burden of the complete system should be considered. The following additional assumptions were made in the process of this estimation.

Initial costs of EPBD 2002
The development of the procedures and information campaign occurred a long time ago. Sources from the installation sector estimate these at several million euros, but these numbers are not supported by other reliable sources. For this reason, no amounts for this are included in table 4.2. All installation businesses[144] involved with the cooling systems are expected to initially have spent 2 days on acquainting themselves with the regulations, regardless if they decided to conduct inspections in the end. This accounts for 16 of the 17 hours of knowledge development in table 4.2. The courses and exams to become certified EPBD inspectors were initially undertaken by several hundreds of installers. It is estimated approximately 300 installers have done the EPBD-A course and exam and 200 of them have additionally done the EPBD-B course and exam. As a result, the initial costs after the EPBD of 2002 amount to at least € 1.7 million.

Initial costs of EPBD 2010
The implementation of the EPBD of 2010 in the Netherlands only additionally required inspection reports. Standard inspection reports and an application that automatically generates these were developed. Costs are estimated at several million euros, based on expert interviews. Again, these costs could not be reliably verified. Knowledge development of the companies using this system is estimated at approximately 1 hour (the remaining one of 17 hours of knowledge development) for each company. The extra costs from the requirement in the EPBD of 2010 to issue inspection reports are therefore several millions, but it is not clear with enough certainty how large these costs were in practice. The initial implementation of the EPBD 2002 and 2010 is expected to have cost at least € 1.7 million, plus additional costs for development of systems and an inspection report application.

Yearly costs
The structural costs of the system of the inspections are based on the costs that would occur if compliance was full. The structural costs amount to about € 34 million. The majority of the regulatory costs from the systems are on account of commercial building owners or tenants. The amount of systems that are required to have a regular inspection is estimated at around 450,000[145] of which most fall in the category with the lowest effective rated output. As there is still quite some uncertainty about the number of installations, the regulatory burden from the inspections only gives an indication of the potential costs at full compliance. Actual costs are much lower in practice as the amount of inspections in practice is low and no statistics are

[144] About 400, based on the membership of the NVKL, the organization for installation business that work with cooling systems.

[145] Based on expert interviews. These numbers were used by the installation sector to make the initial business plan. SIRA (2019) assumes there are 310.000 air-conditioning installations in the Netherlands larger than 12 kW, of which 60.000 above 70 kW. RVO was unable to provide us with any information on the amount of installations installed in the Netherlands for which the requirement is in place.

Table 4.2 Estimates of regulatory burden from the introduction of inspections for air conditioning systems in the Netherlands for different parties, in euro

Frequency of costs	Party	Requirement	Amount	Time investment (in hours)	Costs time-investment	Costs per one	Development costs	Total costs	Type costs[1]
Initial	Installation businesses	Development system					-	-	AB + CC
		Developing system of inspection reports (2010)					-	-	CC
		Knowledge development	400	17	€ 367,200			€ 367,200	AB
		Course EPBD-A inspector	300	24	€ 244,800	€ 1,300	**€ 390,000**	€ 634,800	CC
		Course EPBD-B inspector	200	24	€ 163,200	€ 1,600	**€ 320,000**	€ 483,200	CC
		Exam EPBD-A inspector	300	3	€ 30,600	€ 526	**€ 157,800**	€ 188,400	CC
		Exam EPBD-B inspector	200	3	€ 20,400	€ 182	**€ 36,400**	€ 56,800	CC
Total initial costs								**€ 1,730,400**	
Yearly	Commercial building owners/ tenants	Airconditioning inspection							
		- 12 – 44 kW	370,000	4	€ 10,064,000	€ 200	€ 14,800,000	€ 24,864,000	CC
		- 45 - 270 kW	70,000	6	€ 2,856,000	€ 300	€ 4,200,000	€ 7,056,000	CC
		- ≥ 270 kW	10,000	8	€ 544,000	€ 900	€ 1,800,000	€ 2,344,000	CC
	Installation businesses	Re-exam EPBD-A inspector	300	2	€ 4,080	€ 211	€ 12,660	€ 16,740	CC
		Re-exam EPBD-B inspector	200	2	€ 2,720	€ 211	€ 8,440	€ 11,160	CC
Total yearly costs								**€ 34,291,900**	

1 GB = governmental burden, AB = administrative burden, CC = compliance costs.

Source: EIB

available on the actual amount of inspections taking place each year. The time required of building owners/tenants and the costs of the inspection and the included reports are estimated using the size of the system[146] and based on expert interviews.

Additionally, installation businesses would have to invest in the certification of the inspectors every five years by getting them re-examined. As this is a small group and only one fifth of them are expected to have to do this every year, the regulatory burden from this is minimal and could be neglected.

The table does not include any costs for the enforcement system as the Inspectorate has not enforced the system in practice. Therefore, based on the information provided it is not clear how much supervisors would be needed and what an appropriate investment would be for a working enforcement system. A comparison could be made with the system of energy performance certificates. However, the inspection of air-conditioning systems and the reports are not registered in a central database as is the case with EPCs. Also, the fact that the requirement is not connected to a particular moment, such as transactions, complicates potential enforcement. The introduction of an enforcement system would therefore require a potentially large initial investment which would have to involve an overview of the amount and location of systems as this overview is currently not available.

Benefits
The benefits of the current system cannot be determined exactly as it is not clear what the compliance rate is, what recommendations are generally made and what share of the building owners or tenants actually undertake energy saving measures as a consequence of the inspections. From a study by ECN[147] and from expert interviews it can be concluded that the goal of energy reduction is not accomplished in practice. However, several studies[148] have been performed about the energy performance of installations in large buildings in the Netherlands. These suggest that in 70% of the office buildings included in the study the energy performance can be reduced by 30%. However, it is not clear what investments are needed to be able to reach these reductions in energy demand and to what extent these recommended investments would follow from an inspection of the installations. It does indicate, however, that there might be some potential for energy savings. It is therefore recommended to analyze what the benefits of the inspections may be in practice.

4.5 How is the directive implemented in other European countries?

Table 4.3 gives an overview of the inspection systems that all countries in this study have adopted to meet the requirements of the EPBD of 2010.

Heating systems
In all the countries an alternative system is introduced for the inspection of heating installations in buildings. There seem to be two main reasons for this. Firstly, many countries already had existing policies on the maintenance, inspection and replacement of heating systems. For example, in Denmark it is general practice to have voluntary inspections of smaller heating systems every 1 to 3 years. In Germany a register of all boiler systems is in place that is tracked by the district chimney sweeper, which ensures a regular measurement of flue gasses, but also requires insulation measures. If installations do not comply or meet the minimum requirements, they must be taken out of service, which is also encouraged by different subsidy schemes. Checks, as a result, happen more frequently than the EPBD prescribes. In England advice on energy efficiency measures is included in good practice guidelines of the installation industry and combined with regular maintenance. Information

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[146] It is not clear to what extent the prices of the inspections have gone up as a consequence of the requirement to additionally issue an inspection report, but it can be expected this has led to an increase proportional to the total costs of the inspection.

[147] ECN (2016), Energiemanagementsystemen in de utiliteitsbouw.

[148] Duurzaam beheer van gebouwen (2008) Halmos & TNO en Duurzaam beheer and onderhoud van de klimaatinstallaties (2010) Halmos & TNO. Available on http://www.halmos.nl/publicaties/. The study “Het (i) opleverproces van klimaatinstallaties met aansluitend (ii) de overdracht naar beheer” from 2015 (Halmos) concluded that the results from 2006 are still applicable and little improvement is made.

campaigns and subsidies for the replacement of old systems have played an important role in the adoption of alternative systems.

Secondly, inspections were not considered to encourage energy saving measures while it would have increased regulatory burden for households and businesses. The alternative systems that were implemented relate more directly to the measures and have shown to be more cost-efficient than an inspection scheme. England has argued that the minimum standards that were tightened in order to comply with the Energy Efficiency Directive (EED) have, in combination with advice and subsidies to replace inefficient systems, had a larger effect on carbon emissions than an inspection system would have had. Denmark also aims to terminate oil as a heating source by 2035 and has prohibited the installation of oil boilers in new (2013) and existing (2016) buildings when district heating or natural gas is available. Norway has phased out the use of oil for heating of buildings by 2020. The country also encourages to combine the inspection of heating systems with the issuance of an expert EPC and provides the possibility for the regular technician that performs maintenance to also perform the inspection as this limits the costs.

In general, it can be concluded that all countries have taken regulatory burden into account at the implementation of the inspection system to reduce energy demand from heating systems and have chosen to meet the requirements in a more cost-efficient way.

Air-conditioning systems
All countries in the study have implemented a system of inspections for air-conditioning installations. In large, these systems are comparable amongst countries. Denmark has chosen to set the minimum effective output at 5 kW instead of 20 kW (except when these are for industrial use or in use less than 500 hours a year). It is not argued why they have chosen to do so as it increases regulatory burden as more systems require an inspection. Germany has instead adopted a system in which the combination with a regular compulsory maintenance allows for an inspection once every ten years, instead of five. Just as with the inspection of heating systems, in Norway it is encouraged to combine the inspection of air-conditioning and ventilation systems with the issuance of an expert EPC to limit the costs.

In Denmark, England, Germany and Norway databases have been created to which the inspection reports have to be uploaded. This provides countries information on the compliance rate and on the installed systems. In Portugal, it was stated that the inspection of both heating and air-conditioning installations was not deemed efficient considering the limited use of the systems throughout the year. Therefore, no proper system was implemented at the time of writing the concerted action report in 2018.

It can be concluded that many countries did not have a system in place around air-conditioning installations and have adopted systems to meet the requirements of the EPBD. Studies on the efficiency of these systems are sparse. The Concerted Action report of Germany mentions a study that shows benefits from inspections regarding energy saving and innovation. However, it does not research the AC inspection system as a whole (costs, benefits, compliance, enforcement, training, etc.). Cost efficiency of the regulation in itself therefore remains largely unknown.

Table 4.3 **Overview of the different inspection systems for heating and air-conditioning installations in the different countries**[1]

Installation	Denmark	England	Germany	Netherlands	Norway	Portugal
Heating systems	Alternative scheme focused on energy efficiency and phasing out oil and natural gas, inspection for oil boilers every year, 2/3 of oil and natural gas systems are inspected voluntary	Alternative scheme including minimum standards for systems and advice based on a checklist combined with regular maintenance	Alternative system including more frequent compulsory inspections including compulsory measures and replacements	Alternative system including voluntary inspections by private home owners and mandatory inspections for larger installations	Fossil fueled boilers every 4 years for systems between 20-100 kW, every 2 years for systems larger than 100 kW, other fossil fueled heating systems > 20 kW and older than 15 years, once off inspection	Alternative system, including voluntary recommended inspections, additional requirement for the installation of systems larger than 25 kW
Air-conditioning systems	Mandatory inspection every 5 year for systems > 5 kW	Mandatory inspection every 5 year for systems > 12 kW	Mandatory maintenance, frequency based on the manual by professional technician. Every 10 years including advice and recommendations issued by specialist engineer	Mandatory inspection every 5 year for systems > 12 kW	Mandatory inspection every 4 year for systems > 12 kW or serving area > 500 m^2, including inspection of ventilation systems without cooling devices	Alternative system, including voluntary recommended inspections, additional requirement for the installation of systems larger than 25 kW

1 From the Concerted Actions reports of the respective countries and expert interviews.

Source: EIB

Compliance and enforcement
Compliance and enforcement are mentioned in concerted action reports in the different countries. From interviews, however, it is gathered that compliance of inspections of heating and air-conditioning installations is often not a priority in practice. Only Denmark and England mention the possibility of getting a criminal liability or fine in case of non-compliance. However, it is not clear what control system is in place and whether the building owners actually have a reasonable chance of getting caught.

4.6 Conclusions and recommendations

In general, it can be concluded that the system of inspections of heating installations has been implemented relatively efficiently in the Netherlands in light of regulatory burden and potential benefits. Primary reason for this seems the absence of a direct link between the inspections and energy saving measures. The inspection of air-conditioning systems is implemented in a way that it meets the requirements of the EPBD, as in many other countries. There, is, however, no clear reasoning or research available that explains why the requirements have been implemented in the way that they have been implemented. The European Commission provides member states with discretionary room to implement the directive efficiently within the national context, but the researchers of this report have found no analysis of different options of implementing air-conditioning system inspections and their related costs and benefits.

The following recommendations may lead to a more efficient system:
- Firstly, before any improvements to the system are made, it is important to estimate the amount of air-conditioning systems that are installed in the Netherlands in order to determine how large the potential benefits of an inspection system could be. Also, based on a sample of buildings and installations, it could be estimated what additional costs on average have to be made in order to reduce energy consumption and what the benefits would be in terms of energy reduction and carbon emissions. The results of such a study can provide input to facilitate policy decisions on how to implement the directive efficiently and how requirements could be enforced.
- Secondly, regulatory burden of different alternative systems should be considered in analyses. For example, regulatory burden may be reduced by implementing a system where advice on energy efficiency measures is combined with (mandatory) maintenance of air-conditioning systems, as is implemented in Germany and Norway. Germany has managed to extend the validity of the inspection reports to 10 years using this system. Alternatively, the effects of additional policies can be considered, such as the effects of compulsory implementation of recommendations in the inspection report for non-residential building owners as long as these are cost-efficient, as is the case in Portugal.
- Thirdly, mandatory uploading of the inspection reports to a central database, like in other countries, may contribute to more efficient enforcement and policy making. This should only be considered if benefits outweigh costs. Since no information on costs and benefits of improving air-conditioning systems in the Netherlands is available, this should be examined first and could be included in an analysis as recommended in the first bullet point.
- Fourthly, policies to enhance energy efficiency measures for installations must take into account the split incentive in buildings that are rented to tenants. Owners are often not willing to make these investments as they do not profit from a lower energy bill and/or improved comfort themselves.

5 Financial instruments

5.1 What does the directive prescribe?

The directive of 2002 aims to stimulate investments in cost-optimal solutions that lower energy consumption. It does not prescribe member states to put financial instruments in place. It was reasoned that when investments would be cost-efficient, no financial instruments or subsidies would be needed. However, at the moment of the recast in 2010, the EU desired a greater level of investments than had come about after the implementation of the directive in 2002. Therefore, the recast of the directive of 2010 instructs member states to provide financial instruments that catalyze investments in the energy performance of buildings. They are to report to the European Commission about any financial instruments that result from the directive and instruments that promote the objective of the directive. The European Commission examines the effectiveness of the financial instruments and may provide advice or recommendations.

5.1.1 In what areas does the directive provide member states with room for discretion?

Member states are completely free regarding the design of instruments and the volume of investments that are being made in this respect.

5.2 How is the directive implemented into national legislation in the Netherlands?

In the Netherlands, there are a number of subsidies in place to promote energy reduction. Many of these follow from the Dutch commitment to the Paris Agreement and the aim that is in place to reduce the emissions of greenhouse gasses. Such subsidies and programs include financial support for the installation of solar panels, insulation and heat pumps. Also, it has been decided to abolish natural gas as a heating source, implying that all buildings in the Netherlands will be heated by alternative sources in 2050. Many current and future financial instruments will be supporting this transition.

In consultation with ATR, in this study only financial instruments are taken into account that are directly related to energy labels (EPCs). The only subsidies in place in the Netherlands based on energy labels regard social housing. Owners of social housing are incentivized to obtain expert EPCs because of the 'woningwaarderingsstelsel'. This in turn means that when EPCs are used in social housing subsidies, expert EPCs[149] can be provided. Social housing is defined as rental houses with a rent lower than the so-called 'liberalization-limit' of around € 700 a month, of which the majority is owned by social housing corporations. The STEP, short for 'Stimulation regulation for the Energy Performance of social housing' (Stimuleringsregeling Energieprestatie Huursector) subsidy was set in place for investments in the energy performance of the social housing stock[150]. The height of the subsidy depends on the extent of the energy performance improvement based on the different energy classes of the label, with a minimum of two (table 5.1)[151].

[149] It can be argued that the 'woningwaarderingsstelsel' in itself is, because of the financial incentives it provides, also a financial instrument. We have decided only to include subsidy schemes as financial instruments here. The effects of the 'woningwaarderingsstelsel' are included in the regulatory burden estimations in chapter 2.

[150] https://www.rvo.nl/subsidie-en-financieringswijzer/stimuleringsregeling-energieprestatie-huursector-step

[151] Initially, a minimum improvement of three label classes had to be taken, but on July 1st, 2016 this was changed to two. The subsidy per step was also increased and made available for renovations beyond an Energy Index of 1,2 (label A).

Table 5.1	STEP subsidy per house[1] according to the label (Energy Index (EI)) before and after energy-saving renovations, in €

After	A++ (EI≤ 0.40)	A++ (EI≤ 0.60)	A+ (EI ≤ 0.80)	A (EI≤ 1.20)	B (EI ≤ 1.40)	C[2] (EI ≤ 1.80)
Before						
C (1.41 ≤ 1.80)	4,800	3,600	2,800	1,500	0	0
D (1.81 ≤ 2.10)	6,200	4,800	3,600	2,800	1,500	0
E (2.11 ≤ 2.40)	7,200	6,200	4,800	3,600	2,800	1,500
F (2.41 ≤ 2.70)	8,300	7,200	6,200	4,800	3,600	2,800
G (EI > 2.70)	9,500	8,300	7,200	6,200	4,800	3,600

1 With a maximum of € 7.5 million for individual corporations and € 10 million for individual private owners.
2 Only for private owners.

Source: Netherlands Enterprise Agency (RVO)

The subsidy was aimed at houses with an original label of D to G and after the renovation the energy index had to be at least 1.4 for houses owned by corporations (label B) and 1.8 for houses owned by others (label C). With these measures the highest energy consumption reductions are realized. In order to be eligible for the subsidy, proof of the improvement of the energy label of the building must be shown, by providing a label from up to 6 months before the renovation and within 24 months after the renovation[152]. Another prerequisite of the subsidy was that the improved energy performance could not lead to an increase in rent for tenants.

The regulation started on July 1st, 2014 and ended December 31st, 2018. The total available budget was € 400 million, of which € 5 million was purposed for the implementation of the subsidy. At first the maximum subsidy per applicant was € 7.5 million for social housing corporations. This maximum was cancelled as of January 1, 2017. The maximum subsidy per applicant was € 10 million for other owners of social housing. The subsidy has a lead time of two years: this means that only two years after the subsidy has been granted on paper, RVO (the delegated government agency) will check based on the EPC database whether the EPC improvement has occurred. Only then the subsidy is transferred. Up until then, the owners will have to advance the payments.

The subsidy is in place in order to support owners of social housing to reach an average label B in 2020 as was agreed upon in the Dutch Energy Deal in 2013. The subsidy mitigates the effect of the split incentive for owners of social houses. This split incentive means that owners invest in the energy performance of their housing stock, while tenants profit from a reduced energy bill. Though compensation schemes are put in place through which tenants pay corporations a share of the actual reduction of their energy bill, in practice, corporations cannot fully capitalize on their investments in the energy performance of their existing housing stock. The increase in rent is often limited by the liberalization limit of social housing, the social housing deal and legislation regarding assigning households to homes according to their income. In the social housing deal corporations agreed to lower or maintain the total costs of housing (rent and energy bill).

Following the STEP subsidy, for energy-saving measures after January 1st, 2019, the 'Regulation Reduction Owners tax' (Regeling Vermindering Verhuurdersheffing (RVV)) was initiated for social housing corporations. This regulation lowers the tax social housing owners pay by a particular amount per house when the energy performance indicator is improved by at least 3 classes (table 5.2)[153].

[152] Kamerstukken II 2014/2015, 17050, nr. 506.

[153] https://www.rvo.nl/subsidies-regelingen/vermindering-verhuurderheffing.

Table 5.2	Discount on the owners tax per house depending on the Energy Index before and after energy-saving renovations in €

After	A++ (EI≤ 0.40)	A++ (EI ≤ 0.60)	A+ (EI ≤ 0.80)	A (0.81 ≤ 1.20)	B (1.21 ≤ 1.40)
Before					
A (0.81 ≤ 1.20)	3,000	0	0	0	0
B (1.21 ≤ 1.40)	3,000	3,000	0	0	0
C (1.41 ≤ 1.80)	3,000	3,000	3,000	0	0
D (1.81 ≤ 2.10)	5,000	5,000	3,000	3,000	0
E (2.11 ≤ 2.40)	7,000	5,000	5,000	3,000	3,000
F (2.41 ≤ 2.70)	7,000	7,000	5,000	5,000	3,000
G (EI > 2.70)	10,000	7,000	7,000	5,000	5,000

Source: Netherlands Enterprise Agency (RVO)

As with the STEP subsidy, the height of this subsidy also depends on the energy label of the house before and after the renovations, as presented in table 5.2. For the years 2019-2021 a maximum discount of € 156 million was allocated, with a maximum of € 78 million in 2019 and 2020. From 2022 € 104 million will be available every year.

5.2.1 What control system is in place?

Both measures are delegated to the Netherlands Enterprise Agency (RVO) who manage and distribute the subsidies.

5.3 What are the experiences with the legislation in practice?

Up until June 2016, the technical and procedural requirements were seen as stringent[154]. In July 2016, an easing of the requirements took place as a consequence of the criticism and the experience has generally been more positive. Social housing owners remark that they have made considerable additional costs from the subsidy scheme as, in many cases, a new Energy Index must be issued before the renovation (as this had to be issued maximum 6 months before the application) and in every case afterwards as well. On top of that they have invested a considerable amount of time organizing the needed information and the renovations with tenants and construction companies.

Results of the STEP are shown in table 5.3. This table shows that nearly the entire budget of € 395 million has been granted and the majority of the subsidy has gone to social housing corporations (which also own the majority of houses with a rent below the liberalization limit). When the subsidies are granted, the energy-saving renovations still need to take place. They will only be confirmed and transferred at least two years after the application and after it has been proven that the energy label has improved, by submitting an expert EPC from before and after the renovations. Therefore, there is a delay between when the subsidy is granted and is actually spent.

[154] Ecorys (2019), Evaluatie STEP regeling.

Table 5.3 Situation around the application for STEP subsidies on September 1, 2020

	Number of applications	Number of houses granted	Granted subsidies	Number of houses confirmed	Confirmed subsidies
Social housing corporations	4,046	107,472	€370,335,800	103,775	€310,074,500
Other owners	741	5,236	€22,836,142	4,856	€17,592,200
Total	**4,787**	**112,708**	**€393,173,942**	**108,631**	**€327,666,700**

Source: Netherlands Enterprise Agency (RVO)

Concerning the discount on the owners tax for social housing corporations, in December 2019 the total budget for the period 2019-2021 had been granted already. As of May 8, 2019, applications had been received for energy saving renovations on 36,216 houses for a total value of € 132 million[155].

5.4 What are the regulatory burden and benefits of the financial instruments?

5.4.1 Regulatory burden

The implementation costs that were reserved for the subsidy were € 5 million, 1.25% of the total budget of € 400 million. In practice implementation costs were around € 5.6 million (including expected implementation costs in 2020), which equals 1.4% of the total budget. In comparison to other subsidy schemes, this is deemed relatively low[156].

Costs that are made by owners of social housing were not included in the evaluation study. The STEP subsidy requires owners of social housing to obtain two expert EPCs per house, one up to 6 months before the renovation and another up to 24 months afterwards. Therefore, it can be argued that as a consequence of the STEP subsidy owners of social housing have to obtain two additional expert EPCs to comply with the requirements of the scheme. The issuance of two EPCs (from which the Energy Index follows) for homes can be estimated at around € 160 per house when it is assumed that the average price of one EPC is € 80 for owners of social housing. As for approximately 109,000 houses renovations will be performed, this leads to a costs of about € 17.5 million. This is a considerable amount given that the EPCs are only used as proof of the improvement of the energy performance. In practice, social housing corporations and also commercial owners of buildings generally know the state of their property and the ways in which efficient choices can be made. The recommendations included in the expert EPCs are therefore not needed in practice. Given these relatively high costs per house, the question rises whether alternatives could be used in order to provide the needed proof of the better energy performance of the building after renovations.

No indication was made on how much time was spent to organize the necessary information in order to apply for the subsidy. In the calculations of the regulatory burden of the systems of

[155] Kamerbrief, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 21 mei 2019.

[156] Ecorys (2019), Evaluatie STEP regeling.

energy performance certificates in Appendix B it is estimated that social housing corporations approximately have 1 full-time employee in order to reissue 10% of the EPCs of their building stock each year (approx. € 23 million). As this only concerns the issuing of the EPC, it is expected that more employees are needed to obtain a new EPC for the homes that are to be renovated, providing the needed information and organizing the renovations with tenants and construction companies. This results in an increase in regulatory burden. Regulatory burden for tenants depends in large on the type renovations.

5.4.2 Benefits

The main aim of the subsidy scheme is energy consumption reduction and a reduction of CO_2 emissions. An evaluation of the STEP subsidy[157] based on the numbers as of July 1st, 2019, shows that it is expected that about 264,000 extra 'label-steps' have been taken in 109,000 homes for the total amount of € 395 million. Based on the subsidy that has been paid at the time of writing the report (45% of the total), the average amount of label steps per house is 4.1. In most cases this is an improvement from label D or E to A. This is interesting considering the aim to mostly subsidize improvements from label D-G.

Based on the improvement of the Energy Index, the type of dwelling and the year of construction, an estimation is made of the reduction in energy consumption. It was assumed that all renovations have focused on improving the building envelope. While it is known that in practice the renovations also included the replacement of installations, these cannot be estimated and are therefore not included in the calculations. Based on a technical-economic model[158] of standard numbers for energy reductions, it was calculated that a reduction of approximately 93,000 tons of CO_2 emissions is realized every year.

The benefits in terms of a lower energy bill and increased comfort for tenants are not included in the study. Furthermore, it is not clear to what extent investments in renovations would have taken place without the STEP arrangement.

STEP subsidy deemed relatively expensive, extensive cost-benefits analysis needed to determine total effects of the policy
Based on the subsidy of € 395 million and a CO_2 reduction of 93,000 ton, the price of one ton of CO_2 reduction is estimated at over € 4,000. In comparison with estimated costs and benefits of other policy measures in the built environment, these costs are high per ton CO_2. It does not become clear from the Ecorys study what causes this, though studies of policy measures generally use different assumptions, making it hard to compare the efficiency of policy measures.

Furthermore, given that the regulatory burden for social home owners and benefits from the subsidy scheme were not included in the study, it is not possible to conclude on the relative efficiency and proportionality of the policy measure. Regulatory burden may be reduced by allowing simplified energy labels to be used in order to estimate the energy performance before and after the renovations. Alternatively, expert EPCs may be issued for entire buildings (if it is completely renovated) instead of for individual building units.

5.5 How is the directive implemented in other European countries?

Denmark
In Denmark financial incentives based on subsidies are kept to a minimum and, if such measures are employed, they only last for short periods of time. No specific public support schemes in relation to energy efficiency in buildings are in place. Instead there is a strong focus on cost efficient renovations. A tax reduction is available for labor costs related to renovations of buildings. However, this applies to all types of renovations and is therefore not linked to

[157] Ecorys (2019), Evaluatie STEP regeling.

[158] PBL (2017), VESTA MAIS.

energy efficiency improvements directly. Moreover, higher taxation of fossil fuels is used to create a financial incentive for home owners to invest in the energy efficiency of their houses.

England
The use of financial instruments is very limited. Only the Renewable Heat Incentive (RHI) is related to the recommendations section of the EPC, which must be obtained in order to receive subsidy on renewable heating systems such as biomass boilers, solar boilers and certain heat pumps. In the past, tax exemptions for homes corresponding to code level 6 of the sustainable home standard (net zero carbon equivalent) have been in place. However, this scheme only lasted for approximately a year, as the system lacked good quality control and a decent enforcement system. Another financial instrument relates to the obligation of energy service providers to invest in energy performance improvements of buildings in order to accommodate lower incomes in buildings with poor energy performance. Concerning office buildings, MEES (minimum energy efficiency standards) are related to EPCs.

Germany
In Germany no financial instruments are in place that are connected to EPCs. The issuance of the EPCs themselves and energy-saving advice by experts, however, is subsidized in order to stimulate cost-optimal investments. There are many financial instruments on national, regional and possibly local level in place to stimulate investments in energy-saving measures. Some subsidies are implemented through the government-affiliated KfW bank for new houses, renovation of existing houses and the installation of renewable heating systems. Germany does not subsidize measures that are required by law, but it does enhance the awareness of the cost-optimal investments among its citizens and it promotes both energy-saving measures that go beyond current requirements and the development of techniques for more energy-efficient buildings.

Norway
In general Norway promotes investments in the energy efficiency of existing homes by subsidizing part of the investment of particular measures. In order to set the right priorities and take most efficient measures, home owners are encouraged to obtain an expert EPC as this includes a renovation plan in order to get a good indication of efficient measures. The advice is more specific than the generic list of energy efficiency recommendations in the online label. The additional costs of the expert EPC are considered reasonable in light of the benefits in terms of energy savings and reduced CO_2 emissions and up to 50% of the costs for the EPC may be subsidized. The measures in the renovation plan are connected to subsidies of ENOVA, the delegated government agency that covers part of the investment in for example, hot water tanks, solar panels or floor heating.

Portugal
In Portugal the IFRRU 2020 is seen as an important instrument that stimulates urban renewal and improvement of the energy performance of buildings. It provides loans at favorable rates and can be seen as a fund comprised of different funding sources, among which European funds and private bank funds. Within the fund, € 38 million is reserved for the energy efficiency of housing which is to be reached through specific measures that have been selected by ADENE (the delegated government agency). Among these are insulation, replacement of technical systems, windows, hot water systems and renewable energy systems (in total around 130 different measures).

Owners of buildings older than 30 years, of abandoned industrial space and private units that are integrated in a social housing building may apply. In order to apply for a loan, an EPC must be issued that lists all the needed measures to improve the energy performance by at least 20% or by 2 energy classes. With this information, the bank will analyze if the project is eligible and, based on cost optimality studies, a maximum amount of the loan is determined for each measure. Key to this system is that building owners are always required to invest private capital as well. After renovations have taken place, another certificate is made to confirm that the measures were taken.

The loans are issued through four commercial banks in Portugal that analyze the applications and have also invested in the fund. For the extensive use of the EPC in practice, the database of the EPCs is cross-referenced with other databases, such as tax information and the notary system, but also energy providers and the national institute for statistics. This provides an easy way to monitor the (effects of) measures being taken.

Besides the IFRRU 2020, there are some tax deductions in place in particular municipalities for home improvements or highly energy efficient houses. These deductions may also be combined with loans through IFRRU 2020.

Conclusions on the international comparison
In general, it can be concluded that not many countries use the existing system of energy performance certificates to distribute subsidies or other financial instruments. Only in Portugal the EPCs are used to stimulate renovations of existing buildings. In other countries energy consumption reductions are promoted by subsidizing specific measures, such as the replacement of old heating systems in Germany and England. Besides the systems described above, from the expert interviews follows that in many countries national government give regional and local governments the possibility to use EPCs in their tax policies. However, this leads to (large) differences in policies within a country. From the interviews no clear objections are given as to why the EPC is not used in national subsidy schemes and experiences in Portugal show that implementation can be efficient when supported by databases and IT infrastructure.

5.6 Conclusions and recommendations

The system of energy performance certificates is not often used as a policy instrument for measures that aim to improve the energy performance of buildings. It is not clear from the analysis why this is the case. When EPCs are used, it always concerns the use of expert EPCs. As there are no apparent objections against using simplified energy labels as a policy instrument, this possibility may be explored further as simplified labels give a relatively good indication of the energy performance at low cost. The recommendations on efficient measures may be more accurate in case of an expert EPC as compared to a simplified energy label, but, as reasoned before in chapter 3, when decisions are made around whether to use a simplified label or expert EPC, it is important to assess the additional accuracy of expert EPCs in light of the additional costs.

However, if the use of EPCs for policy making is considered, a reliable and accurate EPC becomes more important. In this case, it is advisable to further analyze the implications of keeping simplified labels under the new system (NTA 8800). As described before, taking samples of the results of simplified labels and having the same homes visited by, for instance, three experts, the (possibly) different outcomes in practice can be measured and the desirability of a possibly more accurate expert EPC can be determined.

Currently, there is no reason to assume that home owners deliberately file wrongful information regarding their home. If there are worries over fraud when using simplified labels in combination with, for instance, subsidy schemes, an efficient quality control system needs to be in place. Samples can be taken and high sanctions can be enforced. High sanctions have a deterrent effect and ensure compliance without leading to a large increase in regulatory burden for governments. As stated, decreasing the number of categories (for instance from A-G to excellent-good-average-below average) can decrease the number of disputes and mitigate unwanted effects of inaccurate measurements.

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Appendix A Quantitative calculation of proportionality of measures

This appendix describes a method for determining the proportionality of measures. We define proportionality as the relationship between the regulatory burden and the social benefits of a measure.

Regulatory burden only shows the costs of measures

The regulatory burden of new policies provide insight into the costs that citizens, businesses and government will have to incur to comply with the new policy. The way in which the regulatory burden must be quantified is described in the 'Handboek Meting Regeldrukkosten' (Ministerie EZK, 2018). The manual contains guidelines for determining both the initial costs and the average annual structural costs. The benefits of the policy (for example savings on energy bills and a reduction in CO_2 emissions), however, do not form part of these regulatory burden and are not included in the calculations.

Assessment of proportionality also requires insight into the (net) benefits of measures

In order to be able to give a proper assessment of the regulatory burden of a measure, there must also be insight into the benefits of the measure. A measure with relatively high regulatory burden (costs) and even higher benefits will have a positive net effect on wealth, while a measure with relatively low costs but comparatively lower benefits will make a negative net contribution on wealth. Insight into the proportionality of a measure is necessary to be able to assess the magnitude of the regulatory burden. This means that in addition to the regulatory burden, other social costs and benefits must also be identified.

Social cost-benefit analyses provide an overview of all relevant costs and benefits

In practice, social cost-benefit analyses are often carried out in order to present the social costs and benefits of policy. This economic instrument for assessing all social effects of measures stems from the general welfare theory. This instrument makes it possible to group all costs and benefits that develop differently over time under one denominator and to make them mutually comparable. Non-priced external effects such as CO_2 emissions are also valued on the basis of shadow prices and can therefore be included in the total balance of costs and benefits. In this way, the total welfare effect of a measure can be mapped out. The applicable directives can be used to determine the benefits of the measure. In theory, the regulatory burden must be part of the costs of the measure.

All relevant costs and benefits must be included in the calculation of the social costs and benefits. These costs and benefits are usually spread over time, whereby the costs often precede the benefits. Investments must first be made in order to be able to profit from the benefits over a period of many years. It is important to compare costs and benefits spread over time mutually comparable by discounting and estimate how prices will develop over time. For example, the relative energy price development is important for savings on the energy bill. There are many degrees of freedom in applying the discount rate and, for example, energy price development. This also applies to the valuation of non-priced securities. To limit these degrees of freedom, various guidelines have been drawn up nationally and internationally on how social costs and benefits should be quantified and valued. For example, the Dutch CPB and PBL have drawn up the 'Algemene Leidraad voor maatschappelijk kosten-baten analyse' (2013). The European Commission (EC) has drawn up a guideline based on a social cost-benefit analysis to calculate the cost-optimal levels of energy performance requirements for new buildings. The directive is included as delegated regulation (EU) No. 244/2012 to supplement Directive 2010/11/EU.

Assessment of proportionality: ratio between net benefits and total costs of policy

In theory, a social cost-benefit analysis (SCBA) provides the desired information to be able to assess the proportionality of a measure. An SCBA provides information about the net balance of costs and benefits of the measure and therefore to what extent the measure makes a positive or negative welfare contribution in Dutch society. All cost items can also be distinguished separately so that the total costs of the measure are known.?? Comparing the total welfare effect against the total costs of the measure offers the desired insight into the proportionality of the measure.

EC guideline for cost optimality calculation as the basis for the calculation

In the context of the EPBD directive, the EC has drawn up a guideline for determining cost-optimal levels of packages for the energy performance requirements for new buildings. This guideline contains concrete rules about which costs and benefits must be distinguished, valued and discounted. This produces a balance of all social costs and benefits over time. This guideline can serve as an excellent starting point for quantitatively charting the proportionality of measures.

The directive focuses in particular on the investment and maintenance costs of measures and the resulting benefits. Other cost items that also form part of the regulatory burden must therefore be explicitly included in the calculation in determining the cost optimality. It must be taken into account whether these costs are not already part of the investment and maintenance costs used. If this is the case, this should be corrected. In contrast to the determination of the regulatory burden, a time path must also be drawn up in order to estimate how large regulatory burden will be, for example by estimations of the development of the number of transactions that will take place in the future. In this way, the development of the regulatory burden over time can be discounted in the total welfare effect.

Assess proportionality in relation to other policy alternatives

The proportionality of a policy measure must be assessed in relation to other policy alternatives. To what extent do other policy alternatives score better than the chosen policy measure? An alternative is the so-called zero alternative, where the measure is not chosen. This is also the alternative against which the balance of social costs and benefits in an SCBA are compared to. With a negative balance of social costs and benefits, a measure has a negative welfare effect compared to the alternative of doing nothing. In itself this is a valid argument for not implementing the measure. However, there may also be political considerations for considering the measure nevertheless. In this case, the magnitude of the regulatory burden can also be taken into account separately in order to assess whether the costs for citizens, businesses and government are in a favorable proportion to the welfare effect. With a limited loss of wealth against low regulatory pressure effects, the consequences of the assessment for total welfare are also limited, while with a strong negative balance of social costs and balance or high regulatory burden, the negative consequences for welfare are much greater.

A positive net balance of social benefits does not automatically imply that the measure is the best choice for society. If a higher positive social welfare effect can be obtained with a different (design of a) measure or if a comparable welfare effect can be obtained at lower (regulatory) costs, then this measure is preferable from a social point of view. There may be political considerations for deviating from this, but then the loss of additional social benefits can be explicitly included in the consideration. The recommendation is to include other promising alternatives in the calculation when working out the proportionality of a measure. Calculating the proportionality of a measure alone does not provide sufficient basis for a proper assessment.

Approach for quantitative determination of proportionality of measures

- Conduct a social cost-benefit analysis to quantitatively map out all relevant social effects
- Include all regulatory burden explicitly in the calculation of the costs and avoid double counting
- Assess proportionality in respect to doing nothing and other policy alternatives

Appendix B Regulatory burden from current EPC system

This appendix presents the regulatory burden from the entire system of energy performance certificates in practice. The burden is differentiated between initial costs to set up the system and structural costs that occur on a regular basis. For both the initial and structural costs a difference is made between administrative burden (the costs that are made to provide the necessary information, including the time spent to comply with the requirements) and the compliance costs (the costs that follow from a change in behavior or a change of the actual state of buildings). Also, the governmental burden is presented. First the initial regulatory burden will be shown for the system that has been in use since 2015. After that the structural costs are presented on a yearly basis.

Since the publication of the studies described in chapter 2, the hourly rate of professionals has increased from € 45 to € 54. In chapter 2 the tariffs are kept at € 45 in order to improve comparison. In the tables presented here, the new hourly rate is used in the calculations based on the current guidelines.

Initial regulatory burden
The system that has been in use since 2015 has been introduced in different stages. However, in order to get an overview of the total regulatory burden from the system that was implemented as a consequence of the EPBD recast of 2010, the different elements are presented as if they were introduced at the same time (table B.1). The total initial costs of the current system of energy performance certificates and simplified energy labels are around € 31 million. The majority of these costs are for the government and follow from the development of the webtool for the calculation of the energy performance for simplified energy labels (approx. € 15 million). Knowledge development of businesses around the new system and the development and providing proof of the right skills are estimated to be around € 8.6 million. Compliance costs are negligible. The results rely on the following assumptions.

<u>Government</u>

- The largest share of the initial costs from the current system of energy performance certificates lies with the government investment in the online webtool. The webtool is used to issue the simplified energy labels for private home owners. In consultation with RVO, the Dutch government agency that manages the tool and the energy label database, the costs for this tool and the accompanying instruction course are estimated around € 15 million.
- RVO also organizes a one-day instruction course for energy experts to be able to use the tool. Costs for this are part of the operating costs and we estimate these around € 50,000.
- Costs made by RVO in order to develop a list of cost-efficient measures which are included in the energy label were part of the regular activities of RVO and could not be identified individually.

<u>Businesses</u>
At the implementation of the initial additional requirements of the EPBD of 2010, all building owners had to spend time updating their knowledge. A study from 2009[159] estimated that there were in total approximately 437,500 buildings. Given a growth of 8% of the amount of non-residential buildings between 2012 and 2019[160], it is assumed that the amount of non-residential buildings is now around 475,000. There is no information available on the amount of buildings owned by single owners.

[159] moBius consult (2010), Bepaling aantal utiliteitsgebouwen in Nederland.

[160] CBS, https://opendata.cbs.nl/statline/#/CBS/nl/dataset/81955NED/table?ts=1593693148021.

Table B.1 Initial regulatory burden from the system of energy performance certificates in the Netherlands for different parties, in euro

Sector (party)	Requirement	Amount	Time investment (in hours)	Costs time-investment	Costs per one	Total fees	Total costs	Type costs[1]
Government (RVO)	– Application development					€ 15,000,000	**€ 15,000,000**	GB
	– Development expert training					€ 50,000	**€ 50,000**	GB
Businesses	– Knowledge development requirements EPBD 2010	317,000	0.5	€ 8,559,000			**€ 8,559,000**	AB
	– Knowledge development simplified energy labels	14,815	1	€ 800,000			**€ 800,000**	AB
	– Modification advertising system					€ 20,000	**€ 20,000**	CC
	– Instruction training webtool	1,600	8	€ 691,200			**€ 691,200**	AB
	– Course residential advisors	1,400	24	€ 1,814,400	€ 975	€ 1,365,000	**€ 3,179,400**	AB
	– Course non-residential advisors	400	24	€ 518,400	€ 975	€ 390,000	**€ 908,400**	AB
	– Exam energy experts	200	1	€ 10,800	€ 182	€ 36,400	**€ 47,200**	AB
	– Exam residential advisors	1,400	6	€ 453,600	€ 600	€ 840,000	**€ 1,293,600**	AB
	– Exam non-residential advisors	400	7	€ 151,200	€ 1,000	€ 400,000	**€ 551,200**	AB
Total initial costs				**€ 12,998,600**		**€ 18,101,400**	**€ 31,100,000**	
Total government burden							**€ 16,030,000**	
Total administrative burden							**€ 15,050,000**	
Total compliance costs							**€ 20,000**	

[1] GB = governmental burden, AB = administrative burden, CC = compliance costs.

When it is assumed that half the buildings are in possession of an owner that owns only one non-residential building, while the other half is in possession of owners that on average own three buildings, the average building owner owns 1.5 buildings. This results in approximately 317,000 owners that will have to invest in their knowledge development, including other professionals that do not own buildings but deal with large real estate. They spend on average half an hour to read into the changed legislation, so the total costs amount to approximately € 8.6 million.

- Professionals in the field dealing with the simplified energy labels and the expert EPCs, such as real estate agents, solicitors, appraisers and commercial buildings owners, have to update their knowledge after the implementation of the new system. These costs have been estimated by SIRA[161] to be around € 800,000. Given that approximately 1 hour is needed of these higher educated professionals with a rate of € 54 an hour[162], this comes down to nearly 15,000 professionals. This seems reasonable given the amount of real estate professionals that are a member of large representative organizations (4,400 real estate agents that are member of the NVM, 4,600 appraisers that are member of the NRVT, 1,300 solicitors[163]) and assuming this is only a share of the actual total (given additional staff, etc.).
- The systems with which buildings are advertised (mostly online) have to be modified to include the energy label. As this can be seen as part of regular maintenance, these costs are estimated to be low, around € 20,000.
- All energy and residential EPC experts are required to follow a free 1-day instruction course at RVO about the use of the online webtool.
  Energy experts for the simplified labels may be qualified EPC experts for residential buildings. However, also other professionals have the opportunity to undertake an exam in order to prove their expertise. SIRA[164] estimates that there are around 200 energy experts that are not also EPC experts. This seems reasonable considering results of expert interviews. In case these have all undertaken the exam of 1 hour with a cost of € 182 (SVM NIVO), the total costs for both the time investment (administrative burden) and the costs of the exam (compliance costs) amount to around € 36,000. The training of EPC experts for both residential and non-residential buildings includes a three day course that costs around € 1,000[165]. Given that there are around 1,400 experts for residential houses and 400 experts for non-residential buildings, the total costs are estimated at € 1.4 million and € 400,000 respectively.
- The examination of EPC experts take up to 6 (residential)and 7 (non-residential) hours. The costs for the exams are about € 600 for private homes and € 1,000 for other buildings[166]. It is assumed here that experts pass the exam at once. In practice this will not always be the case, which increases the costs. The total administrative burden is about € 1.3 million for residential EPC experts and € 550,000 for non-residential EPC experts.

Yearly regulatory burden
Table B.2 and B.3 present the structural regulatory burden on a yearly basis. The total yearly costs from the energy performance certificate system as it is implemented in the Netherlands are nearly € 100 million. The administrative burden amounts to around € 91 million and is mostly on account of social housing corporations and non-residential building owners. The government burden is around € 6 million. The compliance costs of the EPBD are minimal and only result from the requirement to display the label in public buildings or commercial buildings frequently visited by the public (nearly € 1 million). The following assumptions were made in these calculations.

[161] SIRA Consulting (2014), Regeldrukeffecten vernieuwd energielabel voor woningen.

[162] From 'Handboek Meting Regeldrukkosten' (2017), Ministry of Economic Affairs and Climate. This hourly rate is applied in all subsequent calculations.

[163] These numbers are found on the websites of the respective organizations.

[164] SIRA Consulting (2019), Lastenmeting wijziging energieprestatiemethode en inijking energielabels.

[165] The training courses and exams for EPC experts are delegated to commercial companies. It is therefore assumed that the development of the courses and the exams are covered by the respective costs.

[166] Website CITO and the same as in SIRA Consulting (2019), Lastenmeting wijziging energieprestatiemethode en inijking energielabels.

- Private home owners
  Based on housing transactions from existing houses[167], on average about 175,000 houses change owners each year. Based on a study from Kadaster[168] in about 75% of these transactions the seller is a private household, which results in around 130,000 yearly labels.

  It is assumed that for all transactions an energy label must be obtained[169]. Though it may be argued that some private home owners already obtained an expert EPC before the introduction of the simplified energy labels in 2015, it is unknown how many households might have done that and some households may have still obtained an energy label after taking energy saving measures as the costs are low.

  The costs presented are therefore the maximum costs from the requirement. It is expected that home owners need 2 hours on average to collect all the necessary information for the energy label at an hourly rate of € 15. Costs for the label itself are estimated to be € 10. The total administrative burden and compliance costs for private home owners amounts to over € 5 million per year.

- Social housing corporations
  Corporations are assumed to purchase expert EPCs for 10% of their housing stock on a yearly basis, given that EPCs have a validity of ten years. The total housing stock of social housing corporations is around 2.3 million[170]. Given that many social houses are similar and the costs amount to around € 80 to € 100[171] (compared to around € 200 for individual houses), it is assumed that around 30% of the houses have to be visited on-site for which a tenant has to be home for approximately 1 hour. Finally, the housing corporations have to organize the purchase of the EPCs and the contact with tenants for the on-site visit of the expert. It is assumed that this costs corporations approximately € 100 per house. There are about 300 social housing corporations in the Netherlands.

  If they all have 1 full-time staff member[172] that is responsible for the EPCs, this would mean that they spend on average just over 2 hours per house. This seems like a reasonable approximation. Total regulatory burden from the EPC requirements for social housing is estimated at around € 47 million a year.

- Commercial owners of residential buildings
  Commercial owners own approximately 960,000 houses in the Netherlands[173]. When these houses are rented, a valid energy label must be available. This would mean that in case of full compliance, every year on average 10% of the total amount of houses would require a new energy label. It is assumed that the purchasing of the simplified label takes about 2 hours for the professional. As some houses are similar, it is expected that tenants have to be home in half of the cases to provide access to the building for 1 hour and the costs of the energy label are € 5 as the issuance of multiple labels at the same time may reduce the price. Total costs for commercial owners and tenants amount to nearly € 12 million of which the largest share (€ 11 million) is for the commercial home owners.

[167] CBS (2020), Bestaande koopwoningen; verkoopprijzen, woningtype, prijsindex 2015=100. Retrieved from https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83906NED/table?ts=1591777636151.

[168] Kadaster (2019), In beeld: de groeiende rol van particuliere verhuurders op de Nederlandse woningmarkt.

[169] In practice around 250,000 simplified energy labels are registered every year (RVO), however, only labels that are required for transactions are included in the calculations here that follow from the EPBD. Also, the fact that some households choose to obtain an expert EPC instead of a simplified energy label is not included here.

[170] CBS (2020), Voorraad woningen; eigendom, type verhuurder, bewoning, regio. Retrieved from: https://opendata.cbs.nl/statline/#/CBS/nl/dataset/82900NED/table?ts=1591785684947.

[171] Aedes, expert interview.

[172] 1 fte = 1836 hours.

[173] CBS (2020), Voorraad woningen; eigendom, type verhuurder, bewoning, regio. Retrieved from: https://opendata.cbs.nl/statline/#/CBS/nl/dataset/82900NED/table?fromstatweb.

Table B.2 Yearly regulatory burden from the system of energy performance certificates in the Netherlands for building owners and businesses

Sector	Party	Requirement	Amount	Time invest-ment (hours)	Costs time-investment	Costs (each)	Total fees	Total costs	Type costs[1]
Residential	Private home owners	Simplified energy label	131,250	2	€ 3,937,500	€ 10	€ 1,750,000	**€ 5,250,000**	AB
	Social housing corporations	Expert EPC	230,000			€ 80	€ 18,400,000	**€ 18,400,000**	AB
		Organisation – contact with tenants				€ 100	€ 23,000,000	**€ 23,000,000**	AB
	Tenants	Receive EPC expert	69,000	1	€ 1,035,000			**€ 1,035,000**	AB
	Commercial housing	Owners	96,000	2	€ 10,368,000	€ 5	€ 480,000	**€ 10,848,000**	AB
	Tenants	Receive owner	48,000	1	€ 720,000			**€ 720,000**	AB
	Businesses	Delivery new houses	80,000	0,5	€ 2,160,000	€ 5	€ 400,000	**€ 2,560,000**	AB
Non-residential	Commercial owners	Obtain EPC	23,750	4	€ 5,130,000	€ 800	€ 19,000,000	**€ 24,130,000**	AB
		Display EPC	15,000	1	€ 810,000			**€ 810,000**	CC
	Public buildings	Obtain and display EPC	500	5	€ 135,000	€ 800	€ 400,000	**€ 535,000**	GB
Businesses	Energy experts	Refreshment course	640	8	€ 276,480	€ 300	€ 192,000	**€ 468,480**	AB
	EPC residential advisors	Re-exam	280	6	€ 90,720	€ 600	€ 168,000	**€ 258,720**	AB
	EPC non-residential advisors	Re-exam	80	7	€ 30,240	€ 1.000	€ 80,000	**€ 110,240**	AB

[1] GB = governmental burden, AB = administrative burden, CC = compliance costs.

Table B.3 Yearly regulatory burden from the system of energy performance certificates in the Netherlands for government and total

Sector	Party	Requirement	Amount	Time investment (hours)	Costs time-investment	Costs (each)	Total fees	Total costs	Type costs[1]
Government	ILT	Enforcement		9,180	€ 495,720			€ 495,720	GB
	RVO	Training experts						€ 10,000	GB
		Maintenance application						€ 5,000,000	GB
Total yearly costs								**€ 93,631,160**	
Total administrative burden								**€ 86,780,440**	
Total government burden								**€ 6,040,720**	
Total compliance costs								**€ 810,000**	

[1] GB = governmental burden, AB = administrative burden, CC = compliance costs.

- <u>Businesses</u>
  At delivery of new houses developing companies must supply the new owners of the building a simplified energy label, also when this concerns social housing. In the past ten years, the average amount of houses that has been added (either by being built or by transformation of existing buildings) is around 86,000[174]. Given that there are exceptions for some type of buildings, such as independent student housing, and some of these houses are built by the owners themselves, it is assumed that for approximately 80,000 houses an energy label must be obtained.

  In many cases these may be issued for a series of similar houses, which lowers the amount of time spend to 0.5 hour and the costs to € 5 on average. Total regulatory burden of energy labels for new houses adds up to about € 2.6 million.

- <u>Commercial owners of non-residential buildings</u>
  The requirement to have an EPC for non-residential buildings leads to administrative burden and compliance costs. Firstly, for all non-residential buildings that are sold, delivered or rented an EPC must be obtained. As previously mentioned, it was estimated that in 2009 there were around 475,000 non-residential buildings. For this study it is assumed that approximately 5% of these buildings require a valid EPC every year. Given that in 2010 only 10,000 non-residential buildings had an EPC, it is reasoned that all 23,750 buildings require a new EPC. Building owners are assumed to spend on average 4 hours to organize the purchase and receive the EPC expert. Costs for non-residential EPCs are predicted to be around € 800 on average. Additionally, for commercial non-residential buildings larger than 250 m^2 that are frequently visited by the public the EPC must be displayed, if it is available. Based on CBS[175] and Geon (2012)[176] it has been estimated around 300,000 commercial buildings are required to display the EPC[177]. This is around 60% of all non-residential buildings. Therefore, from all EPCs that are issued each year, 60% must be displayed, which is expected to take up to 1 hour. Costs from displaying the label therefore amount to € 810,000 every year. Total costs for non-residential building owners amount to € 24 million.

- <u>Public non-residential building owners</u>
  It is estimated that there are about 5,000 public buildings in the Netherlands which are required to have and display the EPC[178]. These might not all be larger than 250 m^2 but it is assumed that this share weighs up to potential other type buildings that are in use by government and are frequently visited by the public. On a yearly basis about 10% of these buildings will have to renew the EPC, which, just as with commercial buildings, is estimated to costs 4 hours for the on-site visit by the expert and 1 hours to display the label. Average costs for the label are also expected to be € 800. Total yearly costs for the government from this requirement is estimated at around € 0.5 million.

- <u>Businesses</u>
  In order to be able to issue simplified energy labels and EPCs, the energy experts are required to follow a refreshment course with an additional test and EPC experts are required to do a re-exam every five years. The refreshment course is obligatory for energy experts and residential EPC experts and was introduced in 2018. Since then, energy experts are required to follow the refreshment course each year. Based on the experience in the

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[174] CBS (2020), Voorraad woningen; standen en mutaties vanaf 1921. Retrieved from: https://opendata.cbs.nl/statline/#/CBS/nl/dataset/82235NED/table?ts=1592836261474.

[175] CBS (2020), Gebouwenmatrix Energie. Retrieved from: https://www.cbs.nl/nl-nl/maatwerk/2019/05/gebouwenmatrix-energie. The total amount of buildings was used in the calculations.

[176] Geon (2012), Onderzoek oppervlaktegegevens utiliteitsbouw. The ratio of the classes of surface areas of buildings was used in the calculations.

[177] This includes offices, business halls, supermarkets, shops, car dealers, wholesalers, hospitality, in- and outside sport facilities and swimming pools that are larger than 250 m^2. Schools, hospital and other health care buildings are not included. This selection is in line with the numbers used in SIRA (2010) Gevolgen administratieve en uitvoeringslasten herzien EPBDr.

[178] Based on the amount of office and conference buildings in use by government or government services, source footnote 78.

period between 2015 and 2019, experts have followed two courses in five years. In the cost calculations it is therefore assumed that every year 40% of all energy experts and residential EPC experts follow the course. Besides, 20% of all residential and non-residential EPC experts are required to do a re-exam with similar prices and time investment that was assumed in the calculation of the initial costs. The administrative and compliance costs from these requirements are in total approximately € 850,000.

- Government

Government has costs from the enforcement system and the maintenance of the webtool and training of energy experts. From the interview with ILT it is estimated about 5 full-time staff members are involved with the enforcement system. The training of energy experts requires a couple of days a year and is estimated at € 10,000. The maintenance of the webtool is estimated at approximately € 5 million each year.

Appendix C Minimum performance requirements

This appendix provides an overview of (the development of) the minimum performance requirements for several building components in the Netherlands.

Table C.1 Minimum performance requirements in terms of efficiency of technical building systems (% of energy used compared to energy delivered), 2013

	2013
Central heating system for residential buildings	71
Central heating system for other buildings	65
Local heating system	63
Hot water supply system	29
Airconditioning installation	75
Ventilation system with ventilation capacity > 5.000 m^3/h, expressed in W/(dm^3/s)	250

Source: Building decree

Table C.2 Minimum performance requirements of thermal insulation in case of new buildings and major renovations, 2003-2015

	2003	2013	2015
Roof	≥ 2.5 m^2K/W	≥ 3.5 m^2K/W	6 m^2K/W
Floors	≥ 2.5 m^2K/W	≥ 3.5 m^2K/W	3.5 m^2K/W
Facade	≥ 2.5 m^2K/W	≥ 3.5 m^2K/W	4.5 m^2K/W
Windows, doors and windowframes	< 4.2 W/m^2K	< 1.65 W/m^2K	< 1.65 W/m^2K
Individual structure		< 2.2 W/m^2K	< 2.2 W/m^2K

Source: Building decree

Table C.3 Minimum performance requirements thermal insulation in case of renovations (not major), 2015

	2015
Roof	≥ 2 m^2K/W
Floors	≥ 2.5 m^2K/W
Facade	≥ 1.3 m^2K/W
Windows, doors and window frames	< 2.2 W/m^2K

Source: Building decree

Appendix D Denmark

Energy performance certificates

Implementation
In Denmark, energy labelling of buildings dates back to 1997. The energy labelling scheme has been revised to meet the EPBD requirements in 2006. The Danish Energy Agency (DEA) is responsible for implementing the EPBD requirements related to Energy Performance Certificates (EPCs) and is in charge of the daily operations, supervision, quality assurance and future development of the scheme. Moreover, the DEA maintains a central database in which all EPCs are registered.

Type of EPC
In the Danish EPC system, the energy performance of most buildings is determined through an on-site assessment of the building characteristics. For single-family houses constructed less than 25 years ago, it is also an option to obtain an EPC without an on-site visit as the year of construction and type of heating system provide a good indication of the measures that are left to be taken. In general, the EPC is based on the calculated energy demand expressed in kWh primary energy per m² year. However, for some rental properties, such as non-residential buildings and multifamily buildings with a detailed and updated operational log, it is allowed to obtain an EPC based on measured energy consumption[179]. The calculation methodology used within the EPC system is the same as the one used to check compliance with the building regulations for new buildings.

Energy performance is rated along a scale ranging from G to A (table D.1). Within the A-label, a further distinction is made according to the building regulations that apply to the respective building. This results in the label A2010 being assigned to buildings that are constructed in accordance with the Building Regulations 2010, A2015 to buildings that comply with the stricter Building Regulations 2015 and A2020 to buildings that comply with the most stringent requirements of Building Class 2020.

Table D.1 EPC rating for residential and non-residential buildings

Energy performance class	A2020	A2015	A2010	B	C	D	E	F	G
Residential (kWh primary energy /m²/year)	≤ 20	≤ 30 + 1,000/ A*	≤ 52,5 + 1,650/A	≤ 70 + 2,200/ A	≤ 110 + 3,200/ A	≤ 150 + 4,200/ A	≤ 190 + 5,200/ A	≤ 240 + 6,500/ A	> 240 + 6,500/ A
Non-residential (kWh primary energy /m²/year)	≤ 25	≤ 41 + 1,000/ A	≤ 71.3 + 1,650/ A	≤ 95 + 2,200/ A	≤ 135 + 3,200/ A	≤ 175 + 4,200/ A	≤ 215 + 5,200/ A	≤ 265 + 6,500/ A	> 265 + 6,500/ A

*Conditioned area in m²

Source: Concerted Action reports

[179] Office buildings and buildings used for administration are required to obtain an EPC based on calculated energy performance when more than 25% of the total heated area is rented.

Usually, the EPC has a validity of 10 years, but this is reduced to 7 years if the EPC identifies major energy savings with a payback time of less than 10 years and with total energy savings (in terms of consumption) of more than 5%. Reducing the validity of EPCs when large energy efficiency improvements can be made that have a relatively short payback time has been up for discussion as the benefits of doing so were questioned. People tend to invest in energy efficiency measures when they buy or sell a house. The reduction of the validity therefore does not influence the decision to renovate.

The price of EPCs for small buildings (< 300 m^2) is regulated and the maximum price lies between € 575 - € 1,000 for on-site assessments[180]. Due to a high level of competition, the price of obtaining an EPC usually lies below the maximum prices indicated above (€ 525 - € 675 for on-site assessments). For remotely issued EPCs the costs are substantially lower (€ 150). For larger buildings the price is not regulated and usually varies between € 0.50 - € 2.00 per m^2.

EPC experts
As of October 2014, prior education was no longer required to become an energy certification expert. Instead a training consisting of obligatory courses, online- and practical tests should be completed. However, the requirements related to becoming an assessor have recently been reviewed as the quality of the EPCs had substantially degraded. Consequently, the courses and tests have become more challenging. Energy certification experts are divided in the following two groups:

- Energy experts that are licensed to label single-family houses and multifamily buildings up to 500 m^2
- Energy experts that are licensed to label multifamily building larger than 500 m^2, public and commercial buildings.

Public & non-residential buildings
The obligation to display EPCs extents to the following building types:

- Buildings > 250 m^2 used for public administration
- Buildings > 250 m^2 occupied by institutions, companies, associations of which more than 50 % of their expenses are covered by public funds
- Buildings > 250 m^2 that are occupied by publicly owned companies or companies where a public body has a final say on decisions
- All buildings > 600 m^2 that are frequently visited by the public

Enforcement
The DEA is responsible for checking compliance with the EPC requirements. In Denmark it is not allowed to collect data that reveals whether a building owner has presented a valid EPC at the moment of transaction. However, very little complaints have been filed. Therefore, it is assumed that the compliance rate is high. Fines, ranging between € 250 and € 6,000 depending on the size of the building, may be applied when building owners fail to comply with the EPC requirements. However, it is difficult to check compliance due to the aforementioned data limitations.

The DEA does perform random quality checks. Each year, 0.25% of the newly issued EPCs are randomly selected for an independent quality assessment. In addition, quality checks are carried out for EPCs that have been subject to complaints. The issued EPC is checked by another energy consultant appointed by the DEA, who carries out a complete on-site assessment. Based on this assessment, the DEA decides whether sanctions (corrections, remarks, public criticism) are required.

Experience in practice
Interviewees argue that, in practice, throughout the stage of occupation the EPC does not lead to more energy efficiency investments. Hence, reduced validity of EPCs should be reconsidered. To limit regulatory burden, Denmark aims to maintain the system of simplified labels.

[180] Maksimumpris for energimærkning af mindre bygninger, www.ens.dk.

Indoor climate is said to be the most important driver of energy efficiency improvements. As such, it is claimed that measures that improve energy efficiency may have a larger uptake when they are marketed as a contribution to a more comfortable indoor climate.

Minimum Energy Performance Requirements

New buildings
Denmark aims to set long-term goals for minimum requirements. In 2008 a goal was set to improve the energy efficiency of new buildings with 75% in 2020 compared to the standard in 2006. The level of 2020 was defined as the NZEB standard and the trajectory towards meeting this goal involved tightening the building regulations in 2010, 2015 and 2020, where each step corresponds to a 25% improvement compared to the 2006 level (table D.2). By including the construction and installation industry in the process, they could anticipate and innovate. This process resulted in reaching the standards earlier, but also gave the government the possibility to timely adjust the definition of NZEB when the standard of 2020 turned out too costly.

Table D.2 **Development of energy performance requirements for new buildings (kWh primary energy demand per m² per year)**

	2006	2010	2015	2020
Residential, 150 m²	84.7	63.0	36.7	20
Non-residential, 1.000 m²	97.2	73.0	42.0	25

Source: Concerted Action

In addition to the requirements set at the building level, minimum thermal insulation levels apply (table D.3). Compared to other countries, these are set at a rather conservative level in order to grant developers more flexibility with respect to the design. Municipalities are the responsible authority with respect to checking compliance with the building regulations.

Table D.3 **Minimal levels of thermal insulation for new buildings**

Building component	Maximum U-value
Walls	0.25
Floors	0.3
Roofs	0.2
Windows, doors and joints	1.35

Source: Danish Building Regulations 2018, edited by EIB

Cost optimal assessments of the building regulations have played an important role in the final definition of the NZEB level. First of all, the BR10 level (the 2010 standard) was not cost-efficient. An explanation for this result is the limited amount of time the industry was granted to meet these standards. However, five years later the BR15 level was cost-efficiently reached. Even though the industry had sufficient time to prepare for the 2020 regulations, these requirements could not be achieved cost efficiently. Only window producers were able to further improve the energy efficiency without letting go of the cost-optimal level. Consequently, the Danish government decided to redefine the NZEB level, which now corresponds to the BR15 level with tightened requirements for windows. It should be noted that an assessment of the current requirements showed that they are beyond cost optimal, whereas these same requirements were found to be cost-efficient in 2015. This can be attributed to the fact that energy prices and taxes have declined over the past years.

Existing Buildings

The definition of major renovations as prescribed by the EPBD has not been implemented, because general belief in Denmark is that this has caused home owners to refrain from renovating. For example, say that someone wants to insulate the roof and the front of the house. Renovating these components would require the owner to undertake additional measures that can be applied cost-effectively within the respective building. As a consequence, the owner may decide not to renovate at all, meaning that an opportunity to improve the energy efficiency of the existing building stock is lost. Instead, Denmark has chosen to set requirements for individual building components that are subject to renovation (table D.4). However, when you can prove that the required level is not cost-optimal, a building owner is not required to execute this measure. This could be the case when a building owner wants to renovate a roof, which already has 250 mm insulation whereas the requirement is 300 mm. In the case of a full replacement of a component, the requirements will have to be met even when the measure is not cost-effective.

Table D.4 Minimum thermal insulation requirements for existing buildings subject to renovation

Building component	Maximum U-value
Outer walls and basement walls adjacent to soil	0.18
Story partitions and partition walls adjacent to rooms with a room temperature between the rooms of ≥ 5 °C	0.40
Ground slab, basement floors adjacent to soil and story partitions to open air or ventilated crawl space	0.10
Ceiling and roof structures, including cupboards under roof slopes, flat roofs and sloping walls adjacent to roofs	0.12
Gates	1.8
Hatches, storm windows and dome lights	1.4
Renovated storm windows	1.65
	Maximum linear loss
Foundations	0.12
Joint between outer wall, window or outer doors, gates and hatches	0.03
Junction between roof structure and skylights or dome lights	0.10

Source: Danish Building Regulations 2018

An alternative for meeting the component requirements is to comply with one of the two voluntary renovation classes, that specify minimum requirements at the building level. The first renovation class will result in a label class A2010, whereas the second renovation class results in a label class C. The benefit of compliance with one of the renovation classes compared to individual component requirements is that the developer can use more degrees of freedom with respect to the design. In practice, these renovation classes are only applied in the non-residential sector.

Experience in practice
In 2014, when the BR15 was still voluntary, more than half of the projects were already built according to this standard. According to interviewees, this indicates that long-term goals can possibly attribute to innovation and may increase the likelihood that future requirements will be met. Denmark argues these positive outcomes are the result of an intense collaboration between the government and the construction sector. The NZEB level in Denmark was initially specified at a rather ambitious level that could only be met by applying PV panels. As PV panels lose efficiency over time, this can result in buildings that no longer comply with the Building Regulations after a couple of years. In addition to the cost-optimality issues, this has been a reason why the Building Class 2020 has remained voluntary.

Inspection of technical systems

Initially Denmark had implemented the requirement for inspection of heating- and air-conditioning (AC) systems by adopting mandatory regular inspections. However, an assessment of the inspection scheme for heating systems showed that it was not cost-effective within the Danish legislative framework. As such, the inspection scheme was replaced in 2012 by alternatives that contribute to increasing efficiency and phasing out oil and natural gas boilers. For oil boilers, the inspection is part of the annual mandatory 'energy measurements' of soot and flue gas. A more thorough inspection might be required for older systems and if measurements are higher than limit values. Besides, a prohibition is in force for the installation of oil boilers in new (2013) and existing (2016) buildings if the area if covered by district heating or natural gas.

The inspection scheme for cooling systems is still in place. All AC- and ventilation systems with an effective rated output of over 5 kW should be inspected every five years. Similar to the EPCs, the inspection report is filed in a database maintained by the DEA.

The Danish government approves experts, provides a list of experts on their website and regulates maximum fees. The owner of the installation is responsible for compliance with the inspection requirements. Criminal liability may apply if the mandatory inspections are ignored. However, due to the lack of a common registry of ventilation system it has not been possible to systematically check compliance with the inspection requirements and therefore no fines have been imposed. The Danish Accreditation and Metrology Fund is responsible for performing controls of inspection reports.

Appendix E England

Energy performance certificates

Implementation
In England and Wales, the Ministry of Housing, Communities and Local Government is responsible for the transposition of the Energy Performance of Buildings Directive (EPBD) into national legislation. As of October 2008, an EPC is required to be issued when a building is newly constructed, sold or let. The requirements with respect to the Energy Performance Certificates (EPCs) that stem from the EPBD 2010 have been transposed in the Energy Performance of Buildings Regulations 2012. Verifying compliance with the EPC requirements is the responsibility of local authorities. In order to facilitate compliance checks, all EPCs and Display Energy Certificates (DECs) that are issued in England and Wales are filed in a central electronic register (Scotland and Northern-Ireland have separate registers).

Type of EPC
Initially the EPC design was similar for all building types and expressed the energy performance in terms of CO_2-emissions. However, the format of the EPC has been revised in 2012 based on an evaluation among consumers. Consequently, the EPCs for residential buildings now have a focus on running costs and potential savings rather than CO_2 emissions. The certificate shows both the current rating of the property (based on the characteristics of the building, a standardized occupancy profile and the energy consumption costs) and the potential rating after the recommended measures have been implemented. Energy performance is rated along a scale, with 1 being the least efficient and more than 92 being the most efficient (this rating results from the calculation software). Moreover, this scale is divided into EPC classes ranging from A-G (table E.1). In 2018, the average asset rating for a residential property was 60 (class D).

EPCs for non-residential properties are still focused on the environmental impact in terms of CO_2-emissions. The CO_2-based asset rating is divided into eight EPC classes (table E.1). Moreover, the current energy performance rating is benchmarked against the rating for a similar building that is newly built and a similar building that is typical for the existing building stock. Recommendations are generated by the EPC software and may be adapted based on the knowledge of the assessor.

Table E.1 EPC rating for residential and non-residential buildings

EPC class	G	F	E	D	C	B	A	A+
Asset rating residential	1-20	21-38	39-54	55-68	69-80	81-91	>92	n.a.
Asset rating non-residential	>150	126-150	101-125	76-100	51-75	26-50	0-25	<0

Source: Concerted Action

In order to obtain an EPC, an on-site visit by a qualified assessor is required. Only apartment buildings for which representativeness of the units can be proven and at least one unit has been subject to an on-site assessment may be exempt. Assessors must make use of government approved software packages. Initially EPCs were valid for three years[181], but with the implementation of the EPBD 2010 this has been extended to ten years.

Finally, obtaining an EPC is relatively cheap. The typical costs related to a residential EPC assessment range from £ 35 - 60 (€ 40 - € 70). For non-residential properties the prices range from £ 129 – 150 (€ 150 - € 175). Low prices have been the result of fierce competition in the EPC market. Although this seems desirable with respect to the regulatory burden, this reportedly has increased the amount of poor quality EPCs.

Additional policy based on EPC
In the United Kingdom, EPCs are employed to facilitate additional energy efficiency policies. With the introduction of the Minimum Energy Efficiency Standard (MEES), landlords and property owners of domestic private rented and non-domestic property are required to upgrade the energy performance of their properties. Currently, the standard requires properties to be improved to at least EPC band E. As there is a further aim to increase the energy efficiency of the building stock to EPC band C or higher in 2030, the minimum standard is intended to be raised to EPC band D by 2025 and C by 2030.

EPC Experts
In order to become an accredited energy assessor, the qualifications and skills set out in the National Occupational Standards (NOS) should be met[182]. An assessor is able to receive different accreditations depending on the type of building and complexity of the building software to be used among others. National Accreditation Schemes are in place to ensure that assessors meet the NOS requirements through training and examination or demonstrating their ability based on relevant experience. Moreover, accredited assessors have to comply with minimum Continuous Professional Development requirements.

Public & non-residential buildings
The obligation to display (part of) the EPC for buildings with a total useful floor area of over 250 m^2, which are frequently visited by the public, only extents to buildings that are (partially) occupied by public authorities. For these buildings a so called Display Energy Certificate (DEC) has to be issued, which is based on actual energy consumption. For buildings with a total useful floor area of over 1,000 m^2 the DEC is valid for a period of 12 months. For all other buildings the validity is 10 years. In contrast to what the EPBD prescribes, there is no requirement to execute the recommendations before the certificate expires.

Enforcement
Monitoring the availability of EPCs is the responsibility of the Local Authorities and they have the power to require the seller, landlord, constructor, real estate agents and letting agents to present copies of the EPC for inspection. In case of non-compliance, a fine may be issued. For residential properties the fine amounts to £ 200 (€ 230) and for non-residential properties the penalty corresponds to 12.5% of the rateable value of the building (with a minimum of £ 500 and a maximum of £ 5,000). Local Authorities are not required to report compliance assessment outcomes to the Government and at the national level no data is collected about the number of penalties is issued in relation to non-compliance by Local Authorities. The Ministry of Housing, Communities and Local Government is responsible for monitoring the quality of EPCs.

Experience in practice
In practice, the seemingly lacking enforcement of EPC requirements has raised discussions with respect to the quality of EPCs. Concerns about the quality of EPCs have recently gained more interest as connecting Minimum Energy Efficiency Standards to EPC ratings has raised the need for good quality assessments and for an enforcement system that guarantees this. Property owners now have an incentive to request multiple EPC assessments and decide to use the one that produces the most favorable rating.

[181] It is unclear why this period has been chosen.
[182] The interview concerning certification of energy assessors has not yet taken place. Results from this session will be included at a later stage.

Additionally, EPCs are registered in such a way (individual PDF documents) that it is difficult to use them for compliance checks or other analyses. A barrier to quality assurance is imposed by the fact that the input values remain hidden within the calculation tools, which makes it difficult to assess whether a produced EPC rating is plausible.

Minimum energy performance requirements

In England and Wales, the minimum energy performance requirements for new and existing buildings have been transposed into part L of the building regulations. The building regulations fall under the responsibility of the Ministry of Housing, Communities and Local Government.

New buildings
Back in 2006 the Government introduced the net zero carbon standard for new buildings, which was supposed to be implemented by 2016. However, this long-term goal has been dismantled by subsequent governments. Although the intermediate uplifts of the building regulations in 2010 and 2013 were implemented, the net zero carbon standard has been suspended until further notice. As a result, the NZEB standard is yet to be defined. Currently the so called future home standard is under consultation and this will likely become the definition of NZEB. However, there is still an ongoing discussion around whether policy should be focused at reducing the energy demand at the building level or decarbonizing the grid.

Based on the latest cost optimal level assessment, the current requirements still correspond to the cost optimal level. As such, the Government is not required to tighten the 2013 building regulations. The only change that will be made in order to comply with the NZEB requirement is the transposition of current minimum requirements into their kWh primary energy per m^2 per year equivalents (table E.2).

Table E.2 Current level of minimum energy performance requirements for England and Wales

Reference building	Primary energy demand ($kWh/m^2/year$)
Semi-detached House	93
Apartment Building	92

Source: Second Cost Optimal Assessment for the United Kingdom, 2018

Up until now, the minimum requirements have been expressed as follows. All new buildings are subject to the Target CO_2 Emission Rate (TER), which is expressed as the mass of CO_2 emitted in kilograms per m^2 of floor area per year. In addition, the building should comply with the Target Fabric Energy Efficiency (TFEE) rate, which is expressed as the amount of energy demand in kWh per m^2 of floor area per year. Newly constructed buildings are not allowed to exceed the limits specified by the TER and TFEE rate. In addition, limits are placed on the properties of fabric elements of the building to ensure acceptable levels of insulation (table E.3). It should be noted that adopting these values may be insufficient to achieve the TER and TFEE rate.

Table E.3 Limiting fabric parameters

Fabric element	Max U-value
Wall	0.2-0.3
Roof	0.2
Floor	0.25
Windows	2.0

Source: The Building Regulations 2010

Enforcement of the building regulations lies with the local authorities, who often delegate their responsibility to private companies. However, checking compliance with the energy performance standards is reportedly often not prioritized. As such, it is difficult to say whether new buildings are actually built in accordance with the energy performance requirements. For larger investors and developers, this is usually the case as they run a reputational risk in case of non-compliance, especially when clients demand energy efficient buildings. However, for the smaller scale builders there might be a larger incentive to deviate from the building regulations if the enforcement is poor.

Existing buildings

The requirements for existing buildings are contained in part L1b of the Building Regulations 2010. Major renovations are specified as more than 25% of the surface area of the building envelope undergoing renovation. When the renovation or (partial) replacement of an individual thermal element constitutes a major renovation or amounts to the renovation of more than 50% of the element's surface area, compliance with the requirements for new buildings set out in part L1a are required when they are technically, functionally and economically feasible. Other work on existing thermal elements should meet cost-effective U-value targets (table E.4)

Table E.4 Cost-effective U-value targets when undertaking works to thermal elements

Building element under renovation	Target U-value
Pitched roof constructions	0.16 – 0.18
Dormer window constructions	0.3
Flat roof constructions	0.18
Solid wall constructions	0.3
Ground floor constructions	0.25

Source : Building Regulations 2010

Experience in practice

The relatively low level of ambition with respect to the minimum energy performance requirements is the result of political considerations. The net zero carbon standard was introduced in 2006, but after the crisis the government prioritized sufficient supply of housing over raising the energy efficiency of the building stock. Currently, further tightening of part L of the building regulations is back on the policy agenda and this is to a large extent supported by the industry.

At the moment, local authorities are allowed to demand energy efficiency levels that are more ambitious than the current building regulations. This has caused requirements to deviate across areas, which leads to a larger administrative burden for builders operating country-wide. For example, the minimum standards with respect to energy efficiency in London are set at 25% below the 2013 level. The current consultation on the future home standard discusses the option to limit the flexibility granted to local authorities. On the plus side, this flexibility is considered to be an important driver of innovation. The areas in which higher standards can be met cost effectively, enable the industry to gain experience that can eventually be applied throughout the country.

Inspection of technical systems

In the United Kingdom alternative measures for heating- and air conditioning (AC)-systems have been adopted. With respect to the heating systems, instead of setting up an inspection scheme the UK has decided to provide advice on boilers/heating systems. An assessment of the alternative measures shows that the corresponding primary energy savings could be more than three times as large compared to using an inspection regime[183].

AC-inspections have been in place since 2009 for systems with a nominal output of over 250 kW, which has been extended to systems with an output over 12 kW in 2011. These systems should be inspected by an accredited energy assessor at least every five years. The inspection reports are filed in the EPC register for quality assurance purposes. A fine of £ 300 may be levied in case of non-compliance. However, no information is available with respect to the compliance to the AC-inspection requirements in practice.

[183] Energy Performance of Buildings Article 8 equivalence.

Appendix F Germany

Energy performance certificates

Implementation
In Germany, the requirements concerning the energy performance certificates are transposed in the Energy Saving Ordinance (EnEV). This has resulted in the introduction of the building energy-certification system in 2007, which has been amended in 2009 and 2013. The EPCs have not been registered until 2014. Due to the strict German privacy law the central database is restricted to metadata (type of certificate and building, new or existing building, responsible local government, assessor) and the database can only be accessed by enforcing authorities and individual experts.

Type of EPC
The EPC is called an 'energy ID' and is required to be presented to prospective buyers or tenants at the viewing of the building at the latest. In this way, the EPC can count as one of the selection criteria when multiple properties are considered. There are two types of Energy ID's available: an energy consumption ID, which is based on the measured energy consumption over the last three years, and an energy demand ID. The former is to a large extent dependent on the behavior of the occupants, whereas the latter reflects the calculated energy demand determined during an on-site assessment by an energy expert. The energy demand ID is recommended by the German Energy Agency (DENA) and required for all new buildings and buildings that undergo major renovations. The measured energy consumption certificate is easier and cheaper but also strongly depends on user behavior. They are only allowed for existing residential buildings with at least five apartments, existing residential buildings with less than five apartments which at least comply with the first German Thermal Insulation Ordinance for thermal insulation (1977) and all existing non-residential buildings. All energy ID's have a validity period of 10 years. The energy performance presents both the final energy demand and the primary energy demand expressed in kWh/m^2 per year (see table F.1 for the scale since 2014).

Table F.1 Implementation of EPC requirement for residential buildings in Germany

Energy efficiency class	A+	A	B	C	D	E	F	G	H
Final energy demand (in kWh/m^2 per year)	< 30	< 50	< 75	< 100	< 130	< 160	< 200	< 250	> 250

Source: EIB

Additionally, the certificate specifies how the final energy demand compares to a similar building that has been constructed according to the evolving minimum performance requirements for new buildings or existing buildings after renovation.

The price of energy consumption certificates is around € 50. For calculated energy certificates it averages around € 300. Due to subsidy programs, consumers will only pay up to maximum € 30 for these calculated on-site assessments.

EPC Experts
There is no official approval or certification procedure for energy performance assessors. Preconditions to be allowed to issue EPCs are defined by regional law for new buildings and based on occupation and a corresponding level of occupational training and/or professional experience for existing buildings. The required qualifications are described in an annex of the EnEV. Several organizations offer customized training. The experts themselves are responsible for assessing whether they meet the requirements or not and risk being fined in case a violation is determined.

Public & non-residential buildings
In Germany no distinction is made between large private buildings frequently visited by the public and other non-residential buildings. Hence, the display certificate is part of every EPC for non-residential buildings. The owner of the building may display this on a voluntary basis, even if not required to do so.

Enforcement
Enforcement of the requirement to present a valid EPC to prospective buyers/tenants is carried out by local authorities, which are allowed to issue fines in case of non-compliance. In addition, Germany uses the so called 'cease and desist letter'. This measure implies that competitors or consumer organizations may sue each other in case of non-compliance. Local authorities are also responsible for the quality control of energy ID's and can impose fines on assessors that do not meet the qualifications.

The quality assessment process of the issued EPCs is as follows: about 5% of the registered EPCs are subject to an automatic validity check of input data by the authorized German Institute for Building Technique (DIBt) on behalf of the local government. The results are communicated to the respective local authorities and assessors. Additionally, 0.5% of the issued EPCs is subject to a check of the input data and verification of the results and 0.1% will have a full check of input data and results, possibly including an on-site visit. Violations concerning the certification regulations can lead to fines up to € 15,000.

Experience in practice
The German system of EPCs is quite complex and does not work very well in practice. The two different EPCs are a result of discussions between stakeholders before implementation, but in practice they have led to weak comparability and the existence of multiple databases and governing bodies. Enforcement of the system is delegated to local and regional governments and, within regions, different government agencies might be responsible for different components of the system. The national government does not receive reports on the status of enforcement. EPCs are relatively expensive in Germany, but compliance rates are reportedly high through the possibility of suing competitors to comply and high subsidies that nearly entirely cover the costs. In practice, therefore, regulatory burden is mostly limited in Germany but the system appears to suffer from a lack of enforcement and accountability. In interviews it is mentioned that, in general, the necessary education and training levels of EPC assessors is high, leading to relatively high costs of on-site visits.

Minimum energy performance requirements

New buildings
Energy performance requirements that are a consequence of the EPBD have been translated into the Energy Saving Ordinance (EnEV) of 2002. The minimum requirements for new buildings are composed of a minimum primary energy demand requirement and a maximum heat transmission of the building envelope. The minimum requirement is not set as a fixed standard, but is dependent on the performance of the building in respect to a reference building type. The reference building type aims to get close to the actual building to be built in terms of

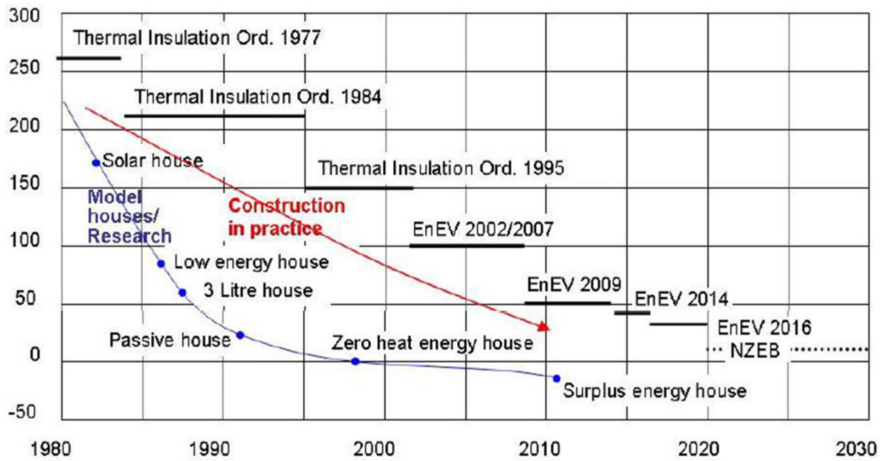
geometry, size, orientation and use, and is constructed with components and technical systems that meet the minimum requirements, leading to a minimum performance.

The use of reference buildings in combination with minimal requirements for thermal insulation is aimed to give designers more freedom to choose an optimal combination of energy efficient measures in order to comply with minimum requirements for primary energy demand and heat transmission. Especially in case of renovations, where it is not always possible to bring all components to a certain standard, this is perceived an advantage of the system.

The evolution of primary energy demand requirements for residential buildings in Germany is presented in figure F.1. The 2009 amendment tightened the requirement in terms of the maximum primary energy demand by 30% on average compared to the level prescribed in the EnEV 2007. The reference buildings are set in 2009 at KfW Efficiency House 100 (Y-axis). In 2016 another 25% reduction was realized as compared to the level of 2009 (KfW Efficiency House 75). The maximum heat transmission of thermal insulation is lowered 20% in 2016 compared to the level of 2009. Figure F.1 shows the development of minimum requirements through time. Based on regular cost-optimality studies, NZEB is defined at the level of 2016 until 2023 when costs for more stringent requirements are possibly reduced enough to be cost-optimal. From interviews it has also become clear that industry lobby has led to a definition of NZEB where no industries or type systems are excluded. The high quality of 'Construction in practice' is achieved through subsidizing energy efficient buildings.

The building of houses that are more energy-efficient than required (e.g. KfW Efficiency House 55, 40 or 40+) is encouraged by the provision of loans and partial subsidies through the national government KfW Bank. The aim of this program is to develop techniques to build more energy-efficient houses at lower costs, in order to be able to tighten minimum standards at cost-optimal levels in the future.

Figure F.1 Development of primary energy requirement for heating in Germany (kWh/m²/year)



Source: Concerted Action, 2012

For non-residential buildings the approach to determine the minimum requirements is similar to the one outlined above. However, the reference buildings are specified into further detail and the requirements regarding heat transmission are expressed as minimum U-values for different parts of the building envelope rather than an average for the building as a whole.

In Germany enforcement is delegated to regional and local governments, which may look very different in the different regions. The energy performance of buildings is part of the existing system of quality control for buildings.

Existing buildings
The mandatory requirements in case of major renovations are defined more stringent in Germany than in the EPBD. They are set when at least 10% of components or the building envelope is renovated and were already implemented in 1976. Considering that it meets the requirements of the EPBD, this has not been adjusted as a consequence of the EPBD. Minimum requirements themselves for existing buildings are significantly less stringent than minimum requirements for new buildings. For example, one way to comply with the requirements is related to the overall energy performance of the building in question, which should not exceed 140% of the energy performance for new buildings that comply with the requirements outlined in the EnEV 2009.

Building components
Requirements with regard to building systems cover the following building components:
- insulation of pipes (heating, DHW and cooling systems);
- controls (heating, DHW, AC and large ventilation systems);
- primary energy expenditure ratio of boilers (heating systems, combined heating and DHW systems);
- mandatory replacement of boilers reaching a lifetime of 30 years (heating systems, combined heating and DHW systems);
- specific fan power (AC systems with a rated output > 12 kW and larger ventilation systems with inlet airflow > 4,000 m^3/h);
- heat recovery (AC systems with a rated output > 12 kW and larger ventilation systems with inlet airflow > 4,000 m^3/h).

These minimum requirements are in place for both new and existing buildings, even though in new buildings the performance of technical building systems is already accounted for in the calculation of the overall energy performance. In general, the building owner is responsible for meeting these requirements, but in practice installers are (partly) responsible.

Experience in practice

Two main conclusions follow from the system of minimum energy requirements in Germany. Firstly, all requirements are set at cost-optimal levels, in contrast to the Netherlands where cost-optimality is lost at the definition of NZEB. Secondly, the system of reference buildings is very complex and expensive as there are many different building types included. In practice, therefore, designers hardly use them. In the future the amount of reference buildings will be reduced.

Inspection of technical systems

Germany has chosen to use the permitted room for discretion with respect to the inspection of heating systems by adopting alternative measures. There is a system in place of recurring measurement of boilers, which includes a potential compulsory shutdown of faulty boilers. In combination with a funding scheme for replacement of conventional boilers with heat generators based on renewables, this system led to energy savings that by far exceed those of an inspection scheme for accessible parts of heating systems as prescribed. The three most effective equivalent measures described and evaluated in the concerted action report in Germany are the taking out of service of old boilers, the recurrent measurement of flue gas losses and several pollutants of boilers combined with compulsory taking out of service in case of non-compliance and the funding programs addressing the replacement of boilers and the improvement of heating systems.

In 2007, a compulsory inspection scheme was introduced for AC systems with an individual rated output larger than 12 kW combined with compulsory maintenance. The combination with regular maintenance allows longer intervals for the inspections than prescribed in the EPBD, currently 10 years in Germany (i.e., twice during normal lifespan) compared to five years prescribed by the EPBD. This inspection scheme is completed by an independent control system for inspection reports, carried out by the same organizations as the control system for energy performance certificates. The inspection reports are registered in the same database, which has been in place since 2014. Local authorities are in charge of the sample controls.

The eligibility of experts is defined by the Energy Saving Ordinance and comprises different possible combinations of fields of study in engineering combined with specific minimum practical experience concerning ventilation- and AC systems. Since May 2014, the experts have to obtain a registration number for each inspection report.

The person or entity in charge of operating an AC system can be fined up to € 5,000 if the inspection is not commissioned in time or not at all. A person who performs an inspection without being entitled to do so (i.e., without having the required professional education and experience) can be fined with such a penalty as well.

Appendix G Norway

Energy performance certificates

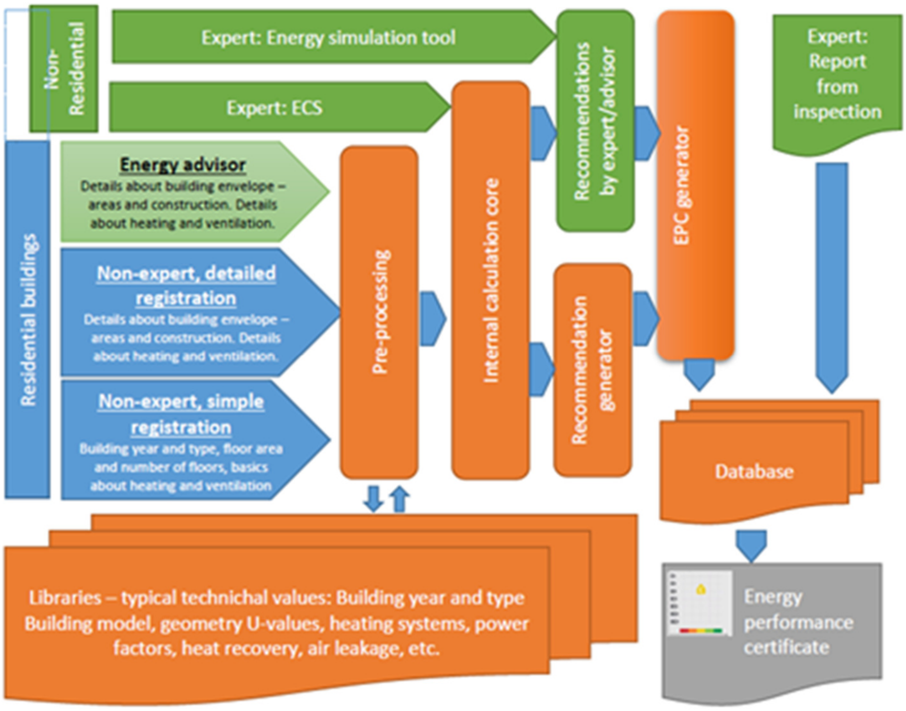
Implementation
As a non-EU member, Norway had implemented the EPBD of 2002 in line with the EEA agreement. The 2010 EPBD however, has been implemented voluntarily with adaptations that Norway felt necessary. Implementation of (parts of) the EPBD 2018 are under consideration.

In Norway the requirements concerning the energy performance certificates have been implemented under the Energy Act as of 2010. Initially the Norwegian Water Resources and Energy Administration (NVE) was responsible for operating the EPC scheme. In 2016, Enova (state-owned enterprise) took over the operations with respect to issuing EPCs based on online registration of building data and storing this data in a publicly accessible central database. The NVE has remained responsible for the control system and imposing sanctions in case of non-compliance.

Type of EPC
The Norwegian Energy Certification System (ECS) is designed to issue energy performance certificates based on different levels of detail, which can be selected by the building owner[184]. The certificate can be based on either a simple registration, which is only intended for buildings that have not been subject to energy performance improvements after construction, or a detailed registration, which requires the building owner to enter more detailed information into the system. Within the detailed registration procedure, conservative default values have been adopted. This creates an incentive for the building owner to replace these default values with the actual values. Moreover, the ECS automatically checks whether the input values are plausible and requires a correction when contradictory information is detected. Expert EPCs are required for non-residential buildings. Experts may use an approved third party energy simulation tool, but the ECS also contains a module specifically designed for this group. Figure G.1 shows a graphical representation of the ECS.

[184] Enova (2017), Description of the Norwegian Energy Certification System.

Figure G.1 Schematic representation of the Norwegian Energy Performance System



Source: Enova

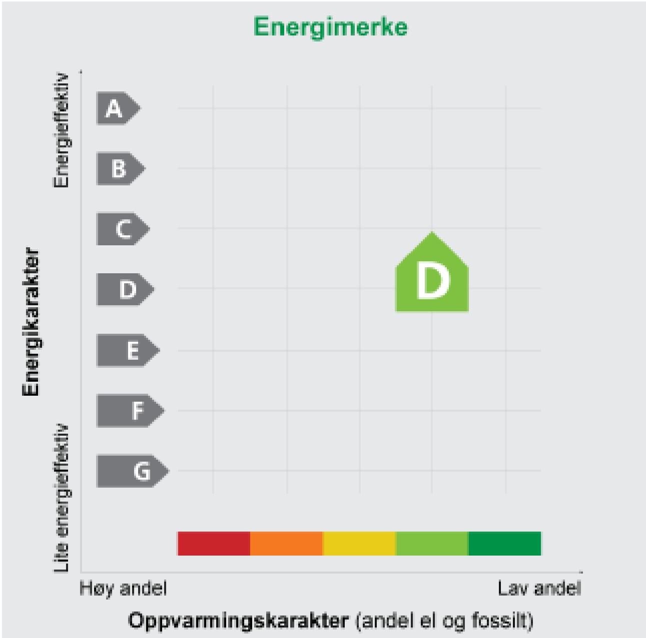
A database is incorporated within the system that, apart from EPCs, also stores inspection reports for heating and AC-systems. Owners of residential buildings have the option to obtain an EPC free of charge without the involvement of an expert.

About 80% of the EPCs are obtained through the non-expert simple registration and 6% non-expert detailed registration[185]. Moreover, 11% of the EPCs are issued by experts that have used verified third party assessment tools and 1.5% has been issued through the ECS expert module. The price of an expert EPC for residential buildings is rarely less than € 200, whereas this ranges between € 1,000 and € 10,000 for non-residential buildings.

The energy performance is rated along two dimensions (figure G.2). On the one hand, energy efficiency expressed in terms of net (final) energy demand is rated from G to A. On the other hand, the renewable energy share is rated along a color scale ranging from red to green, red meaning that heating and hot water are to a large extent delivered by electricity or fossil fuels. This implies that you can have a very energy efficient house (label A), that fulfills this energy demand only by the use of non-renewable energy sources (red).

[185] https://www.energimerking.no/no/energimerking-bygg/energimerkestatistikk/

Figure G.2 Energy performance rating along two dimensions



Source: Concerted Action

EPC Experts

In order to become an expert, the following competence requirements apply: a bachelor's degree in engineering and some experience according to the complexity of the building. Guidance for experts is provided by the government, but no training and examination is required. Moreover, there is no accreditation of EPC experts. Instead experts have to self-assess whether they meet the requirements and document their competence to the building owner and to the government in case of control.

Public & non-residential buildings

The EPBD requirements for public buildings in Norway apply to all non-residential buildings. As a consequence, all non-residential buildings have to comply with the obligation to display the respective EPC. However, it should be noted that the EPBD 2010 is not formally implemented and therefore the display obligation only applies to buildings larger than 1,000 m^2 as is prescribed by the EPBD 2002.

Enforcement

The availability of EPCs at the moment of transaction is controlled by the NVE, which can impose fines in case of non-compliance. The quality of certificates is checked by the ECS automatically when values are put in the system and requires a correction when contradictory information is detected. The most important control mechanism lies with the buyer/tenant, who is expected to evaluate whether the input values listed on the EPC are correct. In 2016 the sample used by the NVE to check the presence of a valid EPC upon transaction was also controlled for input values.

Because it is easy and free of charge to apply for an EPC through the online system, the compliance among home owners is very high. Moreover, potential buyers/tenants are allowed to request an expert EPC at the expense of the building owner if no valid EPC is presented. This creates an additional incentive for building owners to apply for the version that can be obtained for free.

Experience in practice
The EPC system has been designed in a way that all building owners should be able understand and execute the simple and detailed registration. Although the latter can be somewhat difficult for building owners with no knowledge of building physics, the automated control system limits possible errors that occur as a result. Norway intends to maintain the registration system if it decides to adhere to the EPBD 2018.

Even though compliance is high, building owners do not perceive the EPC as something valuable. More energy efficient measures such as higher levels of insulation and heat pumps with low temperature floor heating are considered desirable by occupants, but rather because it leads to a more comfortable indoor climate. Lowering the energy bill is reportedly not really an incentive to take measures as electricity is relatively cheap. Other aspects of buildings, such as location, are perceived to have a much stronger effect on the price than the energy performance rating of the EPC. Moreover, a study based on the Norwegian housing market has showed that the price premium for more energy efficient homes already existed before EPCs were introduced[186]. Hence, the value added by the EPC can be questioned.

Minimum energy performance requirements

New buildings
Over the years, the minimum energy performance requirements contained in the building regulations have been adjusted multiple times (table G.1). Norway has preceded each adjustment with a voluntary guideline, showing the future minimum requirements in order to prepare industries for the change.

In Norway the NZEB standard is yet to be defined, although this level was supposed to be implemented in 2020. To prepare the industry for the implementation of the NZEB level, the latest tightening of the requirements was supposed to match the passive house level. These adjustments came into effect as of January 2016 and remained voluntary throughout the transition period of one year. This transition period is meant to prepare the industry for the future requirements and subsidies are available to projects that are willing to comply with the voluntary guideline. During this period, the passive house level was found to be not cost-optimal. As a consequence, the final requirements that are contained in the TEK17 (current building regulations) have been set at a less ambitious level. The NZEB standard is still under development as it seems difficult to specify this at a cost-optimal level. As Norway has not officially implemented the 2010 Directive, they are able to learn from the implementation of NZEB in other countries before implementing the standard themselves.

[186] Olaussen, Oust and Solstad (2017), Energy Performance Certificates – Informing the Informed or the indifferent?, Energy Policy (2017), vol 111, p.246-254.

Table G.1 Development of minimum energy performance requirements

Requirement	**1997**	**2007**	**2010 (after EPBD 2002)**	**2015 (TEK17 level)**
Net energy demand kWh/m²/year	-	Single-family house: 125 + 1,600/m² HFA* Apartment: 120 Commercial building: 165	Single-family house: 120 + 1,600/m² HFA* Apartment: 115 Commercial building: 150	Single-family house: 100 + 1,600/m² HFA* Apartment: 95 Commercial building: 115
Max area of glass + doors	20% of HFA	20% of HFA	20% of HFA	25% of HFA
Max U-value: exterior wall	0.22	0.18	0.18	0.18
Max U-value: roof	0.15	0.13	0.13	0.13
Max U-value: exposed floors	0.15	0.15	0.15	0.1
Max U-value: glass/doors	1.6	1.2	1.2	0.8
Thermal bridges (normalized U-value)	-	Single-family house: 0.03 Other buildings: 0.06	Single-family house: 0.03 Other buildings: 0.06	Single-family house: 005 Other buildings: not-defined
Min. efficiency of heat recovery in ventilation air	60%	70%	Dwellings: 70% Commercial building: 80%	80%
Max. airtightness	4.0	Single-family house: 2.5 Other buildings (>2 floors): 1.5	Single-family house: 2.5 Other buildings (>2 floors): 1.5	1.5
Max SFP factor kW/(m²/s)	-	Dwellings: 2.5 Commercial building: 2.0	Dwellings: 2.5 Commercial building: 2.0	Dwellings: 1.5
Max screening factor for glass/windows (gt)	-	-	0.15	-

* Heated Floor Area

Source: Concerted Action

In order to comply with the building regulations, developers have two options. The first option contains specific energy limits for different building types, expressed in kWh/m² useful energy demand per year within the building envelope (first row of table G.1). When this option is used, the additional minimum requirements for specific building envelope components are less stringent (table G.2). This approach provides developers with more degrees of freedom with respect to the design of a building. For example, the design of a building with a facade of glass may be compensated by using stricter values on other building components. This way developers may determine which elements are most cost-efficient in reaching the overall performance at the building level. This is particularly beneficial for larger and more complex buildings. The second option, which is only available for residential buildings, only specifies requirements for different components of the building envelope and technical building systems (table G.1). These requirements are set at such a level, that compliance will automatically result in an overall energy performance at the building level that corresponds to the limits set for option 1.

Table G.2 Complementary requirements under the specific energy limits option

Building component	Maximum U-value
Exterior wall	0.22
Roof	0.18
Exposed floors	0.18
Glass/doors	1.2
Airtightness	1.5

Source: Concerted Action

The enforcement of the minimum energy performance requirements is the responsibility of local authorities. However, all new buildings are required to be tested on air leakage upon completion. The developer/construction firm is responsible for hiring an independent expert to perform such a test. Local authorities are required to check whether this test has been performed correctly and whether the building has been constructed in accordance with the building permit based on the submitted paperwork. A random sample of projects is evaluated in more detail by means of an on-site assessment.

Existing buildings
The requirements for major renovations have not been implemented in Norway, as the EPBD 2010 has been implemented with adaptations (given that Norway is not an EU Member State). However, in general the components that are renovated should comply with the requirements for new buildings unless the requirements are not cost efficient.

Experience in practice
During the introduction period, building in accordance with the voluntary guideline is more commonly used for non-residential buildings, whereas homes are usually built in accordance with the effective minimum requirements. However, the construction industry and delivering industries do get time to prepare for the development of products that meet the future requirements. Moreover, the experience gained by developers that use the voluntary guideline may benefit the industry as a whole once the requirements become mandatory.

Inspection of technical building systems

Heating & cooling systems
The Norwegian regulation requires inspections of both heating- and air-conditioning (AC)-systems. As of 2010, the boilers of fossil fuel based heating systems are required to be inspected every four years. If the system is more than 15 years old, the entire heating system is subject to inspection. AC- and ventilation systems with a nominal output of >12 kW or serve an area of more than 500 m^2 are required to be inspected every four years. The inspection may be performed by the same expert that is involved with the maintenance of the installation which may reduce the time spent on the inspection. Inspection reports are filed in the same database as the EPCs. The enforcement of these requirements is done by sampling at the same instance as the sampling of EPCs.

Experience in practice
Even though the estimated amount of fossil fuel based heating systems in use is around 100,000, only 1,000 inspection reports are stored in the database. Hence, the compliance with the inspection system seems to be limited in practice. The compliance with AC-system inspections is slightly higher, but still far from all systems are inspected (4,000 cooling- and 18,000 ventilation systems of the estimated total of 100,000). This implies that inspection of technical systems has no high priority.

Financial instruments

Instruments not connected to the EPC
A national support scheme exists for new buildings of which the design in terms of energy efficiency is more ambitious than the current building regulations. Moreover, regional programs have contributed to an increase in the amount of very energy efficient buildings.

There are also subsidies available for stand-alone measures. These are typically the measures of which the investment costs cannot be fully recovered in terms of a lower energy bill, such as heat pumps, bio-solutions for heat generation and solar energy solutions. A reason why these measures, rather than cost-optimal measures, are supported by financial instruments, is that the latter are often already taken by building owners to create a comfortable indoor climate.

Experience in practice
In practice, the grants with respect to new buildings that are constructed beyond the current requirements are only adopted within the non-residential sector. Residential buildings are rarely built beyond compliance, because home owners are not willing to cover the additional costs of higher energy efficiency as low energy prices limit the ability to recover these costs.

Appendix H Portugal

Energy performance certificates

Implementation
Energy performance certificates were introduced in Portugal in 2009 and updated twice since in order to improve user-friendliness and communicability. In 2011 an extensive process was initiated that involved meeting with about 100 stakeholders. This included mostly technical topics and drawing up protocols with real estate agents.

Type of EPC
The energy performance certificate is based on calculated energy demand. Certificates are always to be drawn up by a qualified expert and involve an on-site assessment. Certificates based on building standards or online tools were not deemed credible enough in Portugal. EPCs do not only show an overall indicator of the energy performance of the building, but also individual indicators on heating, cooling and hot water. Reason for this distinction is because it matches up with the main needs of energy for consumers. Heating has the largest share, then hot water and finally cooling. The weights of the different indicators is the same as in the calculations for the minimum requirements and are set in order to reach a general energy consumption reduction. As there are still a lot of inefficient installations in use in Portugal, the replacement of these systems has a large effect on the energy performance of the building. When no heating or cooling systems are installed, the calculation method assumes the use of common portable systems that are often in use.

For each of the three indicators and the overall indicator the performance is shown based on final energy demand, primary energy demand and the share of renewable energy. The rating of energy labels depend on the minimum energy requirements of the reference building at the moment it is issued. The calculation method is therefore the same for new and existing buildings. For example, the energy rating may be 150% of the energy consumption of a reference building in the year 2013, indicating that the building consumes 1.5 times as much energy than if it were constructed in 2013. The year in which the EPC was issued must therefore be clarified, because in case the minimum requirements are adjusted, energy ratings can no longer be compared one on one against each other. Given that the validity of an EPC is 10 years, there are EPCs in use with different benchmark years.

The costs of an energy label amount to about € 150 for a 3 bedroom flat, while prices vary a lot between € 80 and € 300. Additionally, a tax which ranges from € 28 - € 65 is paid for uploading it into the online database of ADENE, the government agency that executes the implementation of the EPBD in Portugal. For houses prices rise up to around € 300, based on the additional time needed for field work by the experts.

The EPCs are being altered in the near future in order to meet the priorities of building owners/users, which reportedly are the comfort, safety and health of buildings. Based on questionnaires the majority of the buildings are currently found to be either too hot or too cold.

EPC Experts
Quality experts are referred to as engineers or architects with at least 5 years' experience in building energy efficiency. To become a QE, candidates may attend optional training sessions but they all have to pass a required exam offered by ADENE.

Public & non-residential buildings
In Portugal all non-residential buildings owned by private or public parties are defined as public. Therefore, all non-residential buildings larger than the minimum as prescribed by the EPBD (1,000 m^2 at first) and regularly visited by the public are to display its EPC visibly, to increase awareness. Also, they have to be updated every 6 years. Depending on the building

type, the assessment of the indoor air quality which is part of the EPC is updated every two to six years.

Enforcement
Compliance of the EPC requirement is assured by obliging solicitors and real estate agents to report it when no EPC is in place at the moment of sale. Transactions are not allowed when there is no EPC. Signing of renting contracts sometimes also goes through solicitors or real estate agents. However, the seller of the building or the landlord is kept responsible and may be fined. At the start of 2017, 1.2 million buildings (out of a total of 6 million houses) had an EPC, out of which 90% residential. Quality control of the EPC is done by ADENE by training the experts, an automatic input data control system and random checks of EPCs either by evaluating all relevant documents or on site. They also check based on the complaints from (new) building owners.

Experience in practice
The use of EPCs is well accepted in Portugal and different stakeholders all seem to be in favor of the system, even though it is relatively expensive in comparison to other countries. Building owners often see the EPC requirement as an additional transaction tax. In order to promote owners to take the energy saving measures recommended in the EPC, it is now being considered to hand over the EPC at a different time than the moment of transaction. This should create more attention for the EPC.

The calculation method of the energy performance does not coincide with practice in Portugal. For example, heating is only used for about 4 months per year which changes the cost optimality of installing heating systems. Culturally many people in Portugal are used to use portable systems or the air conditioner for heating. The methodology of the energy performance will be adjusted for non-constant usage of heating and cooling systems, which affects the cost optimality of certain measures and therefore the recommendations that follow from the EPCs.

Minimum energy performance requirements

New buildings
The minimum requirements for new buildings, major renovations of existing buildings and building components are all set at the same level in Portugal. The minimum requirements correspond with the calculation method for the energy performance certificates. For residential buildings the requirements are related to a maximum final energy demand for heating and cooling, a maximum value for primary energy for heating, cooling and domestic hot water and a minimum share of renewable energy for domestic hot water (in terms of a minimum solar thermal panel area per occupant). Non-residential buildings are limited by a minimum primary energy requirement for heating, cooling, domestic hot water and lighting.

There have been 2 revisions since 2009 and the current minimum requirement for all building types is an overall energy rating of B-. This can be reached mainly by building a cost-efficient building envelope. The NZEB level is an improvement of 25% above this current requirement. What is clear is that NZEB is defined at such an ambitious level that it is not cost-efficient from a financial perspective. This means that the extra costs from building according to NZEB standards can't be earned back by lower energy bills over 30 years. However, when the monetized benefits of increased comfort and health from this building standard are also taken into consideration, it is found to be cost-optimal. In this way, the limit of cost-optimality is pushed forward much more than in other countries.

Minimum energy requirements are enforced by having to issue a preliminary EPC as a part of the permit before construction, which also shows potential improvement measures. At the end of the construction the actual EPC is made.

Existing buildings
For existing buildings minimum energy requirements for building components and minimum requirements are set to equal levels as for new buildings. Major renovations are defined as 25%

of the building envelope being subject to renovations. The exact reasoning behind this choice has not become clear from the interviews and research.

For large non-residential buildings with a particularly large energy consumption or an energy performance lower than C, there is an obligation to get an Energy Rationalisation Plan made and implement it in practice within 6 years in order to improve the energy performance.

Building components
Requirements have been established for the U-values of walls, roofs, pavements, windows and maximum solar gain for windows and shading, air ventilation and minimum renewable energy sources for solar thermal collectors. Also, minimum efficiency requirements are set for technical building systems.

Experience in practice
The development of building practices has improved in Portugal as a consequence of the tightened requirements in combination with the preliminary EPC. Previously, municipalities rarely checked the energy performance of new buildings, but now it is actually checked. Designers and construction companies are kept responsible and will have to make changes to the building if it does not agree with the initial plan.

At the implementation of the EPBD in 2010, Portugal was in the midst of the global crisis. As a consequence, construction was very low and evolution of building practice was slow. Only last year construction picked up again and slowly the effects of the tightened energy requirements are being put into practice.

Inspection of technical building systems

At first, Portugal implemented the regular inspections as prescribed by the EPBD. However, because of the relatively high costs and the usage of installation for only a couple of months every year, this was not cost efficient. Instead an alternative system is adopted where the frequency of the inspections depends on power usage and fuel used. The installation of heating systems with an effective output rate larger than 25 kW must be performed by a TIM (an experienced engineer/trained technician who manages all the relevant information and documents). Regular maintenance is recommended and is meant to include sizing issues. In the new system that is being developed the qualified expert that issues EPC is meant to provide advice on the energy efficiency of the installations (both heating and air-conditioning). And when a new EPC is issued, the inspection report of the installation is also checked, including the scheduled date for the next inspection.

For non-residential building owners, cost-efficient recommendations regarding technical systems with a payback period of less than 8 years are mandatory. They may be fined otherwise.

Appendix I Interviewees

The following organizations have been interviewed in constructing this report.

Denmark
- Danskbyggerie (representative organization of the construction sector)
- Danish Transport, Construction and Housing Authority (government)
- Bygherreforeningen (home owners organization)

England
- Better Buildings Partnership (NGO for improving energy performance in existing buildings)
- Citizens Advice (consumer organization)
- British Property Federation (commercial real estate organization)
- UK Green Building Council (NGO for improving energy performance in buildings)
- CIBSE (Institution of building service engineers, advice on construction legislation)
- CIBSE certification department* (training of assessors)
- Homes Engeland (government)

Germany
- Ministry of Economic Affairs and Energy (government)
- VZVB (consumer organization)
- ZDB (representative organization of the construction sector)

Netherlands
- Aedes (social housing corporation organization)
- Arcadis (technical consultants)
- Bouwend Nederland (organization for construction companies)
- European Union
- Gemeente Den Haag (local government)
- ILT (control agency)
- Ministry of Interior affairs and Kingdom relations (government)
- NEPROM (organization for developing construction companies)
- NVKL previous manager (organization for air-conditioning companies)
- NVTB (organization for companies that deliver construction materials)
- RVO (delegated government agency)
- SIRA Consulting (organization that often calculates regulatory burden of policy measures)
- SGS Search (company that issues EPCs for non-residential buildings)
- Techniek NL (technical installers organization)
- Vastgoedbelang (commercial building owners organization)
- Vereniging Eigen Huis (private home owners organization)

Norway
- Huseierne (home owners organization)
- Ministry of Petroleum and Energy & Ministry of Local Government and Modernisation (government)
- Veidekke entreprenor (construction company)

Portugal
- Adene (government)
- IFFRU 2020 (financial instrument)
- DECO Proteste (consumer organization)
- AICCOPN (representative organization of the construction sector)

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