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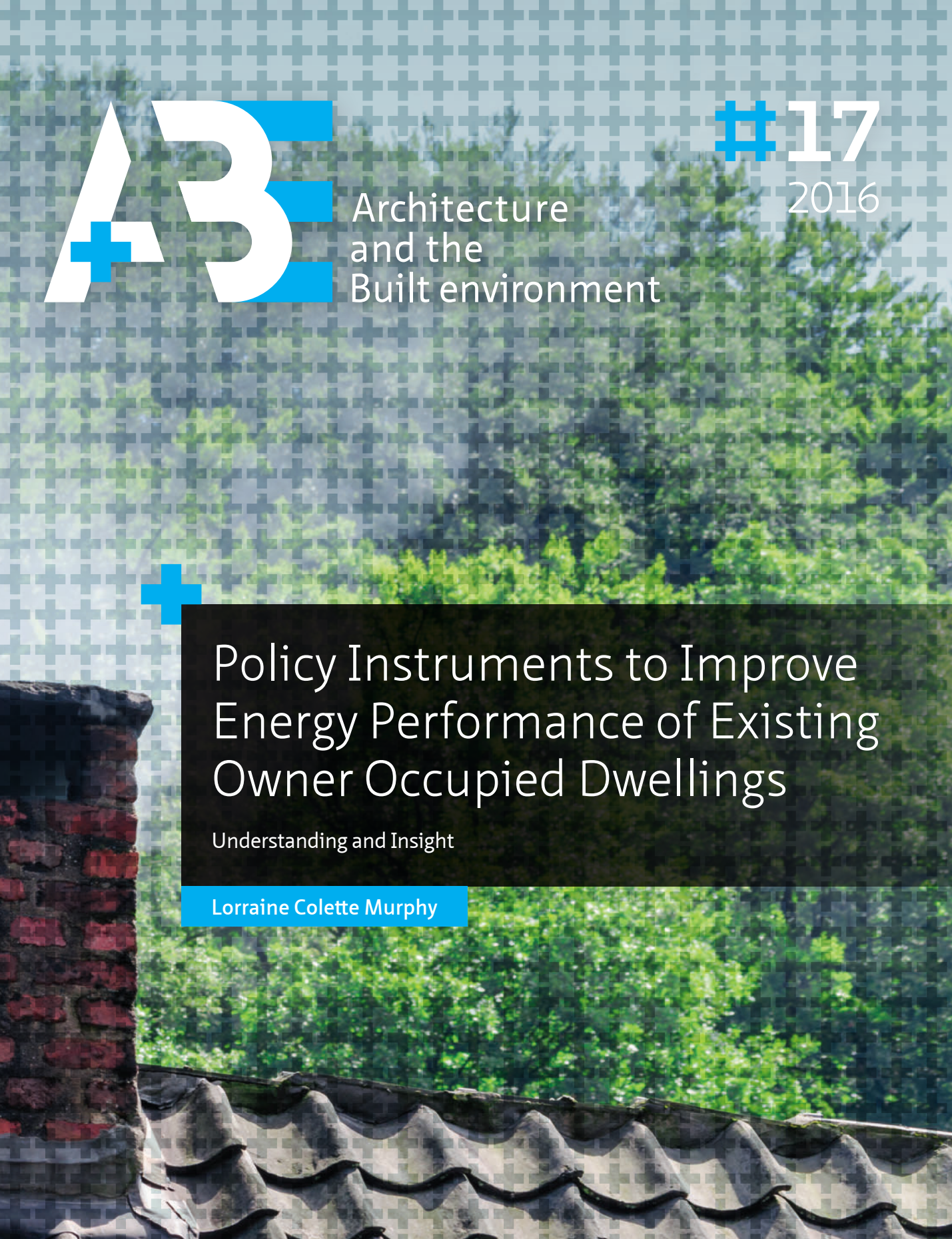

Policy Instruments to Improve Energy Performance of Existing Owner Occupied Dwellings

Understanding and Insight

Lorraine Colette Murphy

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Proefschrift

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Contents

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Summary

Introduction

The aim of this thesis is to add knowledge to the role and impact of policy instruments in meeting energy performance ambition in the existing owner occupied housing stock. The focus was instruments available in the Netherlands in 2011 and 2012. These instruments represented the 'on the ground' efforts to meet climate change targets and many continue to do so today in the same or slightly altered forms.

At international level there is a recognized need to keep global temperatures within the range of 1.5 - 2°C above pre-industrial levels (Carrington, 2016). At European level, the 2020 package contains a series of binding legislation to help the EU meet its more immediate climate and energy targets. 2020 targets include 20% reduction in greenhouse gas emission, 20% of EU energy obtained from renewable sources and 20% improvement in energy efficiency. 2020 targets for the Netherlands are a 20% reduction in greenhouse gas emissions and a 14% increase in energy generation from renewable sources (Vringer et al., 2014).

A raft of policies has been produced over the last number of decades from international to local level to orientate action towards targets. At European level the Energy Performance of Buildings Directive (EPBD) drives efforts at reducing energy among one of the biggest players, the building sector. By requiring a mandatory certificate at the point of sale and rent of buildings and making regulatory demands on existing buildings the EPBD upped the ante of what could be expected from the building sector, but especially the existing dwelling stock.

National governments have already been tackling existing dwellings for decades propelled by the energy crisis and later by climate change policy. Information campaigns, subsidies, energy taxes, energy loans and tailored advice are among the instruments that have been available to homeowners to carry out works on their dwellings to reduce energy consumption. In recent years, the pace of efforts has increased due to, *inter alia*, the realization that the revolution in energy use that must occur for climate change targets to be met means major changes in the fabric of the existing dwelling stock, dwellings constructed before building regulations demanded high energy performance standards. It is argued that the building sector, in general, and the existing dwelling stock, in particular, can contribute more cost effectively and

more significantly in quality and quantity terms than any other sector (Amstalden et al., 2007; Lomas, 2010; Ürge-Vorsatz, et al., 2007). This has provoked calls for new and improved instruments to meet the energy saving potential of existing dwellings.

Despite many of the same instruments being used for decades there is little solid information on many crucial dimensions of how instruments operate and on what impact they have. The few evaluations and reviews that do take place are commonly focused on theoretical energy savings and costs and instrument strengths and weaknesses. Instruments commonly appear and disappear without undergoing improvement or change or contributing to policy learning. Many instruments are laden with assumptions about the target group that are never formally or comprehensively proved or debunked. Little theorizing takes place on the type of instruments most suited to the target group. Fundamentally, there is a serious lack of information surrounding the effectiveness of instruments assumed to be making climate change targets a reality.

It is the above mentioned information deficits that influenced the objectives and structure of this thesis. Instruments are examined from different angles and viewpoints, from experts, owner occupiers, official evaluations and front-runner countries. Assessment frameworks were developed to tease out how well instruments truly function. Households in receipt of instruments such as the EPC and energy audit were compared to households not in receipt of instruments. Moreover, the complete range of national instruments available at the time of the survey were studied to present a complete picture. A more detailed description of the methodologies adopted is presented below.

Methodology

An aim of research was to offer qualified accounts and a deeper analysis of how instruments for energy performance improvement in existing dwellings function. Research components focused on both individual instruments and combinations using a triangulation of methods and sources: expert interviews, a survey and literature review.

The first step towards meeting the aim of research was to characterise and assess national instruments in the Netherlands. In the absence of an assessment framework for policy instruments in this domain one was created using elements of the theory based evaluation method and concepts from literature. All national energy performance instruments operating at the time that could influence energy

performance improvement for space and water heating in existing dwellings were included in the evaluation. Data was obtained from face to face semi-structured interviews with 19 stakeholders involved in lobbying, designing, implementing and evaluating instruments. Interviewee data was complemented with secondary sources, including; evaluations of the national climate change programme, evaluations of individual instruments, cross country evaluations and European projects in which the Netherlands participated.

An online survey of owner-occupiers covering the same instruments as the characterization and assessment of instruments described above was conducted to expand the investigation into instruments. More than 5,000 Dutch owner-occupiers participated in the survey. The survey consisted of 96 questions about energy saving measures adopted within the years preceding the survey. The focus lay on measures that involved significant investment to reduce energy consumed for space and water heating. The questionnaire consisted of multiple choice and open ended questions divided into several categories; the adoption and planned adoption of energy saving measures, energy audits, the EPC, building regulations, the energy tax, financial incentives, information tools and socio-economic and dwelling characteristics. Data on motivations for energy use and perceived influences of instruments was also gathered.

The questionnaire was used to meet several objectives. To survey the overall effectiveness of the national instruments available to owner occupiers at that time, to compare owner-occupiers who received an EPC to those who did not along several parameters and to compare owner-occupiers who received an energy audit to those who did not along several parameters. Required sample sizes were calculated on the basis of assumptions and several critical components of the questionnaire that required a set response rate to allow statistical comparison (See Appendix 2). Approximately, 30,000 households from the national EPC/energy audit database were sent a link to the questionnaire. The comparison group was created by sending approximately 16,000 members of the Home Owners Association a link to the questionnaire. Following a reminder, a response rate of 17% was received for the EPC/energy audit database and 10% for the Association of Home Owners database. Both descriptive and statistical analysis was conducted on response data. Descriptive analysis focused on whether householders reported an association between the adoption of energy saving measures and instrument use. Pearson's chi square tests were used to identify whether an association between adopting measures and instruments could be statistically proven.

The final research component consisted of a comparative study of several front-runner countries to gather knowledge and examine the instruments associated with success in meeting climate change targets for existing dwellings. Literature from comparative public policy was used to structure this research component. Denmark, Germany, Sweden and the UK were chosen as front-runner cases. Based on document analysis

the instruments considered to dominate action in these front-runner countries were characterised. As with the first research component an evaluation framework was developed and the main instruments were assessed against concepts drawn from literature. Using concepts from literature was an effort to go beyond traditional 'strength and weakness' based evaluations by searching for how instruments tackle, or fail to tackle, salient issues in this policy domain. Therefore, 'effectiveness' of instruments was interpreted as both the documented results of goal achievement and the extent to which instruments deal with aspects unique to this policy domain. Results from document analysis and instrument assessments based on concepts were verified in phone interviews with national experts.

Findings

A qualitative evaluation of national instruments

Instruments were evaluated using 1) elements from the theory based evaluation method and 2) a set of 'ideal' concepts. An overview of the first phase of the evaluation is presented in the table below. Fundamental problems with how instruments were implemented were identified in this phase of the evaluation. Most notable was how the EPC was implemented without an enforcement regime resulting in poor visibility, confusion and lack of confidence in the market distancing the EPC from its original ambitious theory and objectives. Similarly, the Meer met Minder sectoral agreement was associated with financial issues and lack of clarity on responsibilities. Economic incentives were heavily criticised by interviewees and found wanting from evaluations being described as 'modest' and 'highly fragmented'. Meanwhile, the energy tax was unanimously described as revenue raising. Little could be obtained from published sources or expert interviewees on the impact of information tools although some interviewees believed that tools are designed for the already informed. Building regulations were found to lack the innovative dimensions visible within other countries, such as consequential works, though few interviewees saw potential to strengthen this instrument.

The second phase of the evaluation examined how instruments functioned compared to normative concepts. Concepts chosen were:

- Policy instrument combinations
- Obligating/incentivising balance
- Long term programme
- Non-generic
- Primacy to energy efficiency
- Whole house/deep retrofit
- Energy sufficiency (the notion that instruments actually lead to energy use reduction)

Elements of some concepts were present but far from pervasive. Instruments were:

- Typically stand alone instead of operating in combinations
- Largely short term instead of being embedded in a long term framework
- Almost entirely incentivising thus lacking the obligating balance suggested from theory
- Generic thus ignoring the great diversity associated with households
- Largely bypassing the important role of first securing energy efficiency before implementing other measures (i.e. renewable technologies)
- Piecemeal in place of whole house
- Disassociated from an end point of energy use reduction.

Some ingredients for a successful strategy for existing dwellings were however present. The Meer met Minder subsidy was the only performance based subsidy in place at the time of research and was associated with positive results. With subsidy amounts linked to rating changes in the EPC/energy audit it also demonstrates a successful coupling of instruments. Furthermore, interviewees, though regretful of how the EPC had been progressing, remained hopeful for a better future for this instrument with scope for different manipulations for example, with links to property taxes.

INSTRUMENT	UNDERLYING THEORY	IMPACT
Energy Performance Certificate		
Displays the energy performance of a building. Required during sale & rental of properties.	Drives market demand for energy efficient dwellings	a)16% of sellers produced an EPC in 2010 (CBS 2011) b)2.7% premium for properties rated A, B or C (Brounen and Kok 2010) c)Majority of householders do not value EPC as a source of information (Adjei et al 2011)
More with Less Covenant		
Government & market parties work together to reach 2020 climate change policy goals in existing buildings. Short term goal: 20-30% 'additional' energy savings in 500,000 dwellings between 2008 & 2011	Shares responsibility among stakeholders towards achieving common policy goals. Anticipates, explores &/or supports regulation.	2008-2010 'additional' energy saving of 20% achieved in 314,000 dwellings (MmM 2011)
Economic Instruments		
Loans	Reduces financial barriers for households conducting energy saving measures	No formal monitoring & evaluation. Reportedly, low application rate with lower income applicants uncommon
Subsidies & VAT reduction	Incentivises 'additional' energy saving & diffusion of innovative technologies & renovation concepts	Contribution to More with Less covenant goals-no formal monitoring & evaluation
Energy tax	Enforces the polluter pays principle	Negligible influence on behaviour (BZK 2011)
Information tools		
Energy audit	Reduces barriers caused by lack of information	No information on adoption of energy saving measures following receipt of personalised information.
Web-based (interactive) Tools	Reduces barriers caused by lack of information	No information on adoption of energy saving measures following use of information tools.
Telephone & Email Advice - Consumer Organisation	Reduces barriers caused by lack of information	No information on adoption of energy saving measures following receipt of information.
Building Regulations		
Minimum standards during renovation/ extension. New building standards during complete renewal	Issues legal standards for energy performance in existing dwellings	Impact not evaluated but considered minor due to low ambition of standards & low replacement rate of stock

TABLE 1.1 Summary of national instruments, underlying theories and impacts

Do energy performance policy instruments work on owner-occupiers?

It emerged from the research component above that many of the perceived successes and failures of instruments were anecdotal. To overcome this a search for associations between instruments and the adoption of energy performance measures was carried out. The main research question was: Are energy performance policy instruments associated with the adoption of energy efficiency measures?

Instruments were found to be largely associated with the adoption of energy saving measures. Exceptions were the EPC and the energy tax. Statistical analysis could not be conducted on energy saving loans due to poor take up among respondents which is nevertheless considered an important finding. Owner-occupier contact with national organisations emerged as a strong instrument with 60% of respondents describing this as an influence in energy efficiency investment. An exception here was contact with Energy Companies. An interesting finding was that the energy audit was not associated with deep retrofit. Confirming the results found in chapter 2, the Meer met Minder performance based subsidy was associated with some successes with 57% of respondents stating that they would not have carried out measures without it while 50% of respondents carried out more measures because of it.

While close to 60% of respondents deemed information and economic instruments as influential it is not an overwhelming result and far from the transformative policy response one could expect given ambitious national climate change targets. What is more, the main reason that respondents did not carry out energy saving measures was because they considered their dwellings to have achieved an adequate level of energy efficiency. Furthermore, high energy users were less likely to adopt energy performance measures.

The influence of energy audits

This research component tested the theoretical assumption that the energy audit, one of the longest running tools for existing dwellings, removes the barrier of inadequate information. A minority of respondents, 19%, stated that the audit rating or recommendations influenced them in the adoption of energy performance measures. The main influence of audits was that they confirmed information already held by householders. When analysed statistically, no significant association was found between having an audit and carrying out energy efficiency measures. Audit recipients were more likely to have installed 1 to 2 measures while non-recipients were more likely to have installed 4-9 measures. Furthermore, non-recipients invested more financially in energy efficiency measures and planned on taking more measures in the future.

A significant portion of audit recommendations were neither adopted nor planned. Furthermore, a significant number of energy saving measures were adopted or planned but not recommended! What is more the main reason that respondents gave for not adopting measures was that they considered their dwellings to be adequately energy efficient. This was despite living in dwellings that would fall within the national policy radar of dwellings that could be improved for energy performance.

The influence of the Energy Performance Certificate (EPC)

At the time of the survey in 2012 the lack of an enforcement regime for EPCs in the Netherlands provided an ideal test environment to compare householders who bought their dwelling with an EPC compared to those who bought it without. The EPC was found to have a weak influence pre-purchase. Only 10% of the EPC sample stated that the instrument influenced the property purchase, mostly in the decision to buy the property followed by an influence on sale price followed by an influence on works to be carried out before occupation in a number of cases. Meanwhile, 22% stated that the EPC influenced the adoption of energy performance measures post purchase. Neither was a statistical significance found for having an EPC and adopting energy saving measures. EPC recipients were found to be more likely to plan on investing in future energy efficiency measures. However, the EPC sample were more likely to live in older dwellings which could also explain this finding. A difference between measures adopted was identified with EPC recipients more likely to have adopted wall insulation and renewable technologies.

Implementation issues and lack of public confidence in this instrument were found. Over 30% of respondents had requested an EPC but did not receive one. Moreover, over half of non-recipients did not request an EPC because they did not consider it necessary.

Despite the implementation issues and disinterest associated with EPCs some positive influences did emerge. In this regard 36% of the EPC sample stated that they would use their EPC as a guide for energy performance improvement.

As with previous research components the nuances of householder decision and non-decision making emerged. While potential buyers were unlikely to negotiate on the basis of an EPC rating a significant portion appreciated that energy efficiency offers value to a property. Similar to the energy audit it is concluded that the EPC is not taken at face value, 50% of recommendations are ignored and a large number of measures were adopted or planned but not recommended.

The policy instruments of European front-runners

In this research component the instruments that dominated action among several of Europe's front-runners were characterised and assessed in a search for some 'general principles' of instruments in this domain. Echoing the first research component the assessment was conducted using a set of 'ideal' concepts as criteria. These were:

- Instrument combinations
- Obligating/incentivising balance
- Long term programme
- Target group differentiation
- Primacy to energy efficiency
- Whole house approach
- Energy sufficiency

The instruments that dominated action among the cases were remarkably different. The German approach was mainly based on subsidizing but at a highly ambitious level, the Danish approach with making regulatory demands at natural moments like renovation, the Swedish approach with creatively combining subsidies and taxes with a long term view of converting energy supply towards renewable sources and the UK approach with obligating energy suppliers and using their 'outreach' capacity to reach energy end users.

Characterizing instruments in terms of content and effect found that while the instruments that dominated action in the chosen cases display some very innovative and effective elements all approaches struggled with achieving adequate levels of ambition for energy retrofit and high levels of participation. Assessing instruments according to criteria developed for this research component showed that no front-runner met all the ideals of policy in this arena. With the exception of the UK approach questions of equitability surround instruments, especially subsidies which appear to be more attractive to the well-off. Front-runners generally embedded their instruments within a long term framework and were moderate to strong in giving primacy to energy efficiency in instrument development. Infusing the core instrument approaches with a whole house perspective was achieved strongly by Germany only. Germany and Sweden excelled at using instruments creatively in combination. The obligation/incentive balance did not appear strongly in the core instrument(s) of any front-runner. A similar result was found for instruments which integrate energy sufficiency. In this case, the UK approach fared best being the only example of where routine monitoring of their main instrument, supplier obligation, was carried out to identify whether energy use was in fact reduced.

Final conclusions and recommendations

Results of this research show a tremendous gap between the ambition of climate change policy at international, supranational and national level and tools used to meet these on the ground. Based on the findings of this research this gap is partly attributed to the voluntary nature of policy instruments and the responsibility of householders in determining an acceptable level of dwelling energy efficiency. It could be argued that (voluntary) energy audits are the cornerstone instruments of existing dwellings where building regulations are the cornerstone of new buildings. Yet research presented here shows that over 70% of audit recommendations are ignored. Survey results found that one of the main reasons for not investing in energy efficiency measures was that householders considered their dwellings to be energy efficient. In stark contrast to policy parlance stressing urgency for 'transforming the stock', 'deep retrofitting' and 'achieving zero' action on the ground is determined by householder perception of an energy efficient dwelling with the support of often modest and fragmented instruments if householders do decide to adopt measures.

Instruments are considered modest as subsidies and loans typically offer minimum financial support for single one-off energy saving measures. At the same time such instruments are often highly fragmented, typically disappearing when budgets are reached. Information instruments are also considered modest with few instruments promoting deep retrofit or innovative measures and approaches. All of the above are considered strong evidence that serious investigation into the role of a minimum standard for existing dwellings is required.

Moreover, more permanent and more innovative instruments are required for existing dwellings. The study into front-runners found such elements, for example, at the time of research 40% of loans for the long running 'KfW Efficiency House' programme in Germany were for renovations pledging to go beyond new build requirements. Given the ambition of targets, instruments promoting such performance based and ambitious approaches should be the norm yet they remain the strong exception rather than the general rule.

Instruments with track records of failing to achieve what they set out in theory require serious investigation, primarily the EPC and the energy tax. Ways to make these instruments mean something to householders and to trigger the changes required in energy use are essential especially as these instrument look set to remain on the policy horizon.

That high energy users were less likely to adopt energy efficiency measures raises an additional challenge to policy instrument development. Instruments that become successful at pushing householders towards improving their dwelling fabric and

installations can only be truly meaningful if householders use energy at a sustainable level. A reworking of the energy tax system to more accurately reflect the polluter pays principle could offer a possibility to influence energy use in a positive direction.

Following on from the above recommendations at the instrument level is a recommendation for a much deeper understanding of owner occupiers and the role of instruments in their decision making. Results presented in this thesis and elsewhere demonstrate the weaknesses associated with the barrier and market transformation models for developing instruments. Instead, owner occupiers and their investment decisions are incredibly nuanced. In this research, for example, householders were found to:

- Ignore the bulk of recommendations offered to them in customized audits even when audits were requested
- Often carry out measures not recommended to them
- Commonly observe the value of energy efficient dwellings but not enough to adopt energy efficiency measures
- Be largely unaware that they pay tax on their energy use
- Be frequently unaware if they pay lower energy bills after adopting energy saving measures even if saving money was a motivating factor for adopting measures.

Research found a deeply entrenched yet unsophisticated manner of conceptualizing policy instruments and owner occupiers and their action or lack of action in adopting energy saving measures. At a basic level, gaps in understanding exist on how instruments are implemented and their impact. At a more complex level, gaps in understanding exist on how instruments can balance competing demands on their performance, notably achieving ambition in energy retrofit and widespread public appeal. Further gaps exist in understanding how the ideals of policy instruments can be truly met such as how instruments can be effectively combined and how energy use can be actually reduced with instruments. More sophisticated theorizing about the instruments that can actually bring the ambitions of global climate change agreements to a reality, with certainty, is a fundamental requirement if existing dwellings are to contribute effectively to meeting targets in the Netherlands and elsewhere.

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Samenvatting

Inleiding

Het doel van dit proefschrift is het verkrijgen van meer kennis over de rol en de effecten van beleidsinstrumenten bij het verwezenlijken van de energiebesparingsdoelen voor de het bestaande koopwoningenvoorraad. Het onderzoek spitst zich toe op de instrumenten die beschikbaar waren in Nederland in 2011 en 2012. Deze instrumenten werden ingezet om om de klimaatdoelen te halen en veel daarvan zijn nu nog steeds in dezelfde of enigszins aangepaste vorm van kracht.

Op internationaal niveau is erkend dat we ervoor moeten zorgen dat de wereldwijde temperatuur niet verder stijgt dan tot 1,5-2°C boven het pre-industriële peil (Carrington, 2016). Op Europees niveau omvat het 2020-pakket een reeks bindende wetgevingsinstrumenten om de EU te helpen haar klimaat-en energiedoelen op de kortere termijn te halen. Deze 2020-doelen omvatten een vermindering van de uitstoot van broeikasgassen met 20%, het opwekken van 20% van de energie in de EU met behulp van hernieuwbare bronnen en een verbetering van de energie-efficiëntie met 20%. De 2020-doelen voor Nederland zijn een vermindering van de uitstoot van broeikasgassen met 20% en een toename van de energieopwekking uit hernieuwbare bronnen met 14% (Vringer et al., 2014).

Er zijn in de afgelopen decennia een grote hoeveelheid beleidsinstrumenten ontwikkeld (op internationaal tot en met lokaal niveau) om de doelstellingen te halen. Op Europees niveau regelt de Energy Performance of Buildings Directive (de EPBD) de inspanningen ter verlaging van het energieverbruik bij een van de grootste spelers, de bouwsector. Door een verplicht certificaat te vereisen op het moment van verkoop en verhuur van gebouwen en door wettelijke eisen te stellen aan bestaande gebouwen heeft de EPBD ervoor gezorgd dat we meer kunnen verwachten van de bouwsector, maar vooral van het bestaande woningenbestand.

Nationale overheden proberen al decennialang het energiegebruik in bestaande woningen te verminderen, onder invloed van de energiecrisis en later het beleid ten aanzien van klimaatverandering. Informatiecampagnes, subsidies, energiebelastingen, energieleningen en advies op maat zijn enkele van de instrumenten die beschikbaar zijn geweest voor huiseigenaren om maatregelen te nemen om het energieverbruik in hun woningen te verlagen. In de afgelopen jaren is het tempo van de inspanningen

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verhoogd, onder andere door het besef dat de revolutie in energieverbruik die moet plaatsvinden om de klimaatdoelen te kunnen halen grote veranderingen vereist in de structuur van het bestaande woningenbestand. Het gaat daarbij om woningen die zijn gebouwd toen de bouwverordeningen nog geen hoge eisen stelden aan de energieprestaties. Er wordt wel gesteld dat de bouwsector in het algemeen en het bestaande woningenbestand in het bijzonder een kosteneffectievere en significantere bijdrage kan leveren, zowel in kwaliteit als in kwantiteit, dan welke andere sector dan ook (Amstalden et al., 2007; Lomas, 2010; Ürge-Vorsatz, et al., 2007). Dit heeft geleid tot de vraag naar nieuwe en verbeterde instrumenten om de mogelijkheden voor energiebesparing in bestaande woningen te benutten.

Hoewel veel van dit soort instrumenten al tientallen jaren worden gebruikt, is er weinig solide informatie over de vragen hoe de instrumenten werken en welke invloed ze hebben. De weinige evaluaties en beoordelingen die wel plaatsvinden, richten zich meestal op theoretische energiebesparingen en kosten en op de sterke en zwakke punten van een instrument. Instrumenten verschijnen en verdwijnen meestal zonder dat ze worden verbeterd of aangepast of als les worden gebruikt voor het beleid. Veel instrumenten gaan gebukt onder aannamen over de doelgroep die nooit formeel of uitgebreid bewezen of ontkracht worden. Er zijn weinig theorieën over het type instrumenten dat het meest geschikt is voor de doelgroep. Er is een fundamenteel gebrek aan informatie rondom de effectiviteit van instrumenten waarvan wordt aangenomen dat ze kunnen helpen de klimaatdoelen te realiseren.

Deze tekortkomingen in de informatie hebben de doelstellingen en de structuur van dit proefschrift bepaald. De instrumenten zijn vanuit verschillende invalshoeken en perspectieven onderzocht, vanuit experts, bewoners, officiële evaluaties en koplopers. Er zijn beoordelingskaders ontwikkeld om na te gaan hoe goed de instrumenten daadwerkelijk functioneren. Huishoudens die instrumenten zoals het energielabel en het maatwerkadvies ontvangen, werden vergeleken met huishoudens geen instrumenten ontvangen. Bovendien werd het complete scala aan nationale instrumenten dat beschikbaar was op het moment van het onderzoek bestudeerd om een volledig beeld te geven. Een uitgebreidere beschrijving van de gebruikte methodologieën is hieronder weergegeven.

Methodologie

Een onderzoeksdoel was het leveren van gekwalificeerde verslagen en een diepere analyse van het functioneren van instrumenten voor het verbeteren van de energieprestaties in bestaande woningen. Onderzoekscomponenten richten

zich zowel op individuele instrumenten als op combinaties met behulp van een driehoeksmeting van methoden en bronnen: deskundigeninterviews, een enquête en een literatuuronderzoek.

De eerste stap voor het behalen van het onderzoeksdoel was het karakteriseren en beoordelen van nationale instrumenten in Nederland. Bij gebrek aan een beoordelingskader voor beleidsinstrumenten op dit gebied werd er een eigen beoordelingskader gemaakt met elementen van de theoretische evaluatiemethode en concepten uit de literatuur. Alle nationale energieprestatie-instrumenten die op dat moment van kracht waren en die van invloed konden zijn op de verbetering van de energieprestaties met betrekking tot verwarming en warm water in bestaande woningen werden opgenomen in de evaluatie. De gegevens werden verkregen uit rechtstreekse, semigestructureerde interviews met 19 belanghebbenden die betrokken waren bij het lobbyen voor en het ontwerpen, implementeren en evalueren van de instrumenten. De gegevens van de geïnterviewden werden aangevuld met secundaire bronnen, waaronder evaluaties van het nationale programma inzake klimaatverandering, evaluaties van individuele instrumenten, landelijke evaluaties en Europese projecten waaraan Nederland deelnam.

Om het onderzoek naar de instrumenten veder te verdiepen, is er een online enquête uitgevoerd onder huiseigenaren over dezelfde instrumenten waarop de hierboven beschreven karakterisering en beoordeling van instrumenten betrekking had. Aan die enquête namen meer dan 5000 Nederlandse huiseigenaren deel. Het onderzoek bestond uit 96 vragen over energiebesparende maatregelen die waren genomen in de jaren voorafgaand aan het onderzoek. De nadruk lag op maatregelen waarvoor significante investeringen nodig waren om het energieverbruik voor verwarming en warm water te verlagen. De vragenlijst bestond uit meerkeuzevragen en open vragen die waren verdeeld over verschillende categorieën: de genomen en voorgenomen energiebesparende maatregelen, het maatwerkadvies, het energielabel, bouwverordeningen, de energiebelasting, financiële prikkels, informatiehulpmiddelen en sociaaleconomische en woningkarakteristieken. Er werden ook gegevens verzameld over motivaties voor energiegebruik en waargenomen effecten van instrumenten.

De vragenlijst diende verschillende doelen: het onderzoeken van de algemene effectiviteit van de nationale instrumenten die op dat moment beschikbaar waren voor huiseigenaren, het vergelijken van huiseigenaren die een energielabel ontvingen met degenen die dat niet ontvingen aan de hand van verschillende parameters en het vergelijken van huiseigenaren die een maatwerkadvies ontvingen met degene die die niet ontvingen aan de hand van verschillende parameters. De vereiste grootten van de testgroepen werden berekend op basis van aannamen en verschillende kritieke componenten van de vragenlijst waarvoor een vooraf bepaald aantal antwoorden nodig was om statistische vergelijking mogelijk te maken (zie appendix 2). Ongeveer 30.000 huishoudens uit de nationale energielabel/maatwerkadvies database ontvingen

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een link naar de vragenlijst. De vergelijkingsgroep werd gevormd door ongeveer 16.000 leden van de Vereniging Eigen Huis een link naar de vragenlijst te sturen. Na een herinnering werd er een response van 17% bereikt voor het energielabel/maatwerkadvies database en 10% voor de database van leden van de Vereniging Eigen Huis. Er werd zowel een beschrijvende als een statistische analyse uitgevoerd op de antwoordgegevens. De beschrijvende analyse richtte zich op de vraag of huiseigenaren een verband meldden tussen de uitvoering van energiebesparende maatregelen en de toepassing van een instrument. Er werd gebruik gemaakt van Pearsons chi-kwadraattoets om te bepalen of een verband tussen de uitvoering van maatregelen en instrumenten statistisch bewezen kon worden.

De laatste onderzoekscomponent bestond uit een vergelijkend onderzoek van een aantal landen die als koplopers kunnen worden gezien voor het vergaren van kennis en het onderzoeken van de instrumenten die in verband worden gebracht met successen op het gebied van klimaatdoelen voor bestaande woningen. Literatuur van vergelijkend openbaar beleid is gebruikt om deze onderzoekscomponent te structureren. Denemarken, Duitsland, Zweden en het Verenigd Koninkrijk werden gekozen als koplopers. De instrumenten die het handelen in deze voorhoedelanden lijken te bepalen, zijn gekarakteriseerd op basis van documentanalyse. Net als bij de eerste onderzoekscomponent werd er een evaluatiekader ontwikkeld en werden de voornaamste instrumenten beoordeeld in vergelijking met concepten uit de literatuur. Deze concepten uit de literatuur zijn gebruikt om verder te gaan dan de traditionele evaluaties op basis van sterke en zwakke punten en om in kaart te brengen hoe de instrumenten opvallende kwesties in dit beleidsgebied aanpakken of niet aanpakken. De 'effectiviteit' van instrumenten werd dus zowel geïnterpreteerd als de gedocumenteerde resultaten voor het behalen van de doelen als de mate waarin de instrumenten aspecten aanpakken die uniek zijn voor dit beleidsgebied. De resultaten uit documentanalyse en de beoordeling van de instrumenten op basis van concepten werden geverifieerd in telefonische interviews met nationale experts.

Bevindingen

Een kwalitatieve evaluatie van nationale instrumenten

De instrumenten werden geëvalueerd met behulp van 1) elementen uit de theoretische evaluatiemethode en 2) een set 'ideale' concepten. Een overzicht van de eerste fase van de evaluatie is weergegeven in onderstaande tabel. In deze fase van de

evaluatie werden fundamentele problemen met de wijze van implementatie van instrumenten geïdentificeerd. Het meest opvallende resultaat was hoe het verplichte energielabel werd geïmplementeerd zonder dat er een handhavingsstelsel was. Dit leidde tot slechte zichtbaarheid, verwarring en een gebrek aan vertrouwen in de markt, waardoor het energielabel zijn oorspronkelijke ambitieuze theorie en doelen niet wist te verwezenlijken. Op dezelfde manier werd de sectorovereenkomst Meer met Minder geassocieerd met financiële kwesties en een gebrek aan duidelijkheid over verantwoordelijkheden. Economische prikkels werden sterk bekritiseerd door de geïnterviewden en uit de evaluaties waarin ze werden gekwalificieerd als 'bescheiden' en 'sterk gefragmenteerd' bleek ook dat ze tekortschoten. Intussen werd de energiebelasting unaniem omschreven als omzetverhogend. Bestaande bronnen en deskundigeninterviews konden weinig licht werpen op het effect van informatiehulpmiddelen, hoewel sommige geïnterviewden van mening waren dat hulpmiddelen vooral ontwikkeld werden voor degenen die al geïnformeerd waren. De bouwregelgeving bleek niet de innovatieve aspecten te hebben die in andere landen wel aanwezig was, zoals secundaire verbeteringen. Toch zagen maar weinig van de geïnterviewden ruimte om dit instrument te versterken.

In de tweede fase van de evaluatie werd onderzocht hoe de instrumenten functioneerden in vergelijking met normatieve concepten. De gekozen concepten waren:

- Combinaties van beleidsinstrumenten.
- Evenwicht tussen verplichting en stimulering.
- Langetermijnprogramma.
- Niet-generieke maatregelen.
- Voorrang voor energie-efficiëntie.
- Heel huis benadering/ingrijpende renovatie.
- Toereikendheid van energie (het idee dat instrumenten daadwerkelijk leiden tot een verlaging van het energieverbruik).

Elementen van sommige concepten waren aanwezig maar zeker niet wijdverbreid. De instrumenten:

- Stonden op zichzelf en werkten niet in combinaties.
- Waren hoofdzakelijk bedoeld voor de korte termijn en maakten geen deel uit van een langetermijnkader.
- Waren bijna uitsluitend stimuleringsmaatregelen, dus het door de theorie voorgestelde evenwicht met verplichting ontbrak.
- Waren generiek en hielden dus geen rekening met de grote diversiteit van de huishoudens.

- Gingen grotendeels voorbij aan de belangrijke regel dat de toereikendheid van energie eerst moet worden gegarandeerd voordat er andere maatregelen worden geïmplementeerd (d.w.z. hernieuwbare technologieën).
- Hadden geen betrekking op het hele huis.
- Stonden los van een eindpunt van energiebesparing.

Sommige ingrediënten voor een succesvolle strategie voor bestaande woningen waren echter wel aanwezig. De Meer met Minder-subsidie was de enige op prestaties gebaseerde subsidie die van kracht was op het moment van het onderzoek die tot positieve resultaten leidde. Met subsidiebedragen gekoppeld aan veranderingen in de scores van het energielabel/het maatwerkadvies bleek ook dat het koppelen van instrumenten succesvol was. Bovendien bleven de geïnterviewden, hoewel ze teleurgesteld waren in de gerealiseerde verbeteringen van het energielabel, hoopvol over een betere toekomst voor dit instrument. Zeker wanneer het gekoppeld zou worden met andere instrumenten, bijvoorbeeld gekoppeld aan de vermogensbelasting.

INSTRUMENT	ACHTERLIGGENDE THEORIE	EFFECT
Energieprestatiecertificaat		
Geeft de energieprestaties van een gebouw weer. Vereist bij verkoop en verhuur van onroerend goed	Stimuleert de vraag in de markt naar energie-efficiënte woningen	a)16% van de verkopers verstrekte in 2010 een energielabel (CBS. 2011)b) 2,7% hogere waarde voor woningen met energielabel A, B of C (Brounen en Kok, 2010) c)meerderheid van huiseigenaren hecht geen waarde aan energielabel als informatiebron (Adjei et al., 2011)
Meer Met Minder		
Formele afspraak tussen de overheid en belangenorganisaties om samen te werken aan het behalen van de klimaatdoelen voor 2020. Kortetermijndoelstelling: 20-30% 'extra' energiebesparingen in 500.000 huishoudens tussen 2008 en 2011	Verdeelt de verantwoordelijkheid voor het bereiken van de gezamenlijke beleidsdoelen tussen de belanghebbenden. Anticipeert op, verkent en/of ondersteunt de regelgeving	2008-2011 'extra' energiebesparing van 20% bereikt in 314.000 woningen (MmM, 2011)
Economische instrumenten		
Leningen	Verkleinen de financiële barrières voor huishoudens die energiebesparende maatregelen willen nemen	Geen formele controle en evaluatie. Naar verluidt weinig aanvragen en weinig gebruikt door aanvragers met lage inkomens
Subsidies en btw-verlaging	Stimuleert 'extra' energiebesparing en verspreiding van innovatieve technologieën en renovatieconcepten	Bijdrage aan doelen van initiatief Meer Met Minder; geen formele controle en evaluatie
Energiebelasting	Geeft uitvoering aan het principe 'de vervuiler betaalt'	Verdragsverandering verwaarloosbaar (BZK, 2011)
Informatiehulpmiddelen		
Maatwerkadvies	Verlaagt de barrières als gevolg van gebrek aan informatie	Geen informatie over uitvoering van energiebesparende maatregelen na ontvangst van het advies
(Interactieve) hulpmiddelen op internet	Verlagen de barrières als gevolg van gebrek aan informatie	Geen informatie over uitvoering van energiebesparende maatregelen na gebruik
Advies via telefoon en e-mail – consumentenorganisatie	Verlaagt de barrières als gevolg van gebrek aan informatie	Geen informatie over uitvoering van energiebesparende maatregelen na ontvangst van informatie
Bouwverordeningen		
Minimumnormen tijdens renovatie/ verbouwing. Nieuwbouwnormen tijdens volledige renovatie	Leggen wettelijke normen op voor energieprestaties in bestaande woningen	Effect niet geëvalueerd, maar naar verwachting klein als gevolg van weinig ambitieuze normen en laag vervangingspercentage van woningvoorraad

TABLE 1.2 Samenvatting van nationale instrumenten, onderliggende theorieën en effecten

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Hebben beleidsinstrumenten voor energieprestaties effect op huiseigenaren?

Uit de bovenstaande onderzoekscomponent bleek dat veel van de waargenomen successen en mislukkingen van instrumenten incidenteel waren. Om dit te verhelpen is gezocht naar koppelingen tussen instrumenten en de invoering van maatregelen met betrekking tot energieprestaties. De belangrijkste onderzoeksvraag was: Houden beleidsinstrumenten voor energieprestaties verband met het uitvoeren van maatregelen voor energie-efficiëntie?

De instrumenten bleken grotendeels verband te houden met de invoering van energiebesparende maatregelen. Uitzonderingen waren het maatwerkadvies en de energiebelasting. Statistische analyse kon niet worden uitgevoerd op energiebesparingsleningen doordat te weinig van de respondenten er gebruik van hadden gemaakt, wat op zich ook een belangrijke bevinding is. Contact tussen huiseigenaren en nationale organisaties bleek een sterk instrument zijn, want 60% van de respondenten achtte dit van invloed op investering in energie-efficiëntie. Een uitzondering in dit verband was contact met energiebedrijven. Een interessante bevinding was dat het maatwerkadvies geen verband bleek te houden met ingrijpende renovatie. In lijn met de resultaten in hoofdstuk 2 bleek de Meer met Minder-subsidie succesvol te zijn, want 57% van de respondenten gaf aan dat ze geen maatregelen zouden hebben genomen zonder die subsidie terwijl 50% van de respondenten meer maatregelen had genomen door de subsidie.

Hoewel bijna 60% van de respondenten vond dat informatie en economische instrumenten van invloed waren, is dit geen overtuigend resultaat en zeker niet in het kader van de ambitieuze nationale doelen op het gebied van klimaatverandering. Bovendien is de voornaamste reden voor het niet uitvoeren van energiebesparende maatregelen het idee dat de woning al voldoende energie-efficiënt was. Daarbij komt dat huishoudens met een hoog energieverbruik minder snel geneigd waren maatregelen te nemen ter verbetering van de energieprestaties.

Het effect van maatwerkadvies

In deze onderzoekscomponent is de theoretische aanname getest dat het maatwerkadvies, een van de langst bestaande hulpmiddelen voor bestaande woningen, de barrière van ontoereikende informatie wegneemt. Een minderheid van de respondenten, 19%, antwoordde dat de maatwerkadviesrating of de aanbevelingen hen hebben gestimuleerd tot het nemen van maatregelen ter bevordering van de energieprestaties. De voornaamste invloed van het maatwerkadviezen was dat

ze informatie bevestigden die de huiseigenaren zelf al hadden. Bij de statistische analyse is geen verband aangetoond tussen het maatwerkadvies en de uitvoering van maatregelen voor energie-efficiëntie. Ontvangers van een maatwerkadvies hadden vaker 1-2 maatregelen genomen, terwijl niet-ontvangers vaker 4-9 maatregelen hadden genomen. Bovendien investeerden niet-ontvangers meer geld in energie-efficiëntiemaatregelen en hadden zij meer plannen voor maatregelen in de toekomst.

Een significant deel van de maatwerkadviesaanbevelingen werd niet uitgevoerd of gepland. Daarnaast werd een aanzienlijk aantal energiebesparende maatregelen uitgevoerd of gepland terwijl ze niet waren aanbevolen. De hoofdreden die respondenten gaven voor het niet uitvoeren van maatregelen was bovendien dat zij vonden dat hun woningen al voldoende energie-efficiënt waren, ook al vielen hun woningen in de categorie die volgens het nationale beleid in aanmerking kwam voor verbetering van de energieprestaties.

Het effect van het energielabel

Op het moment van het onderzoek in 2012 bood het ontbreken van een handhavingsstelsel voor energielabels in Nederland een ideale testomgeving om huiseigenaren die hun woning hadden gekocht met een energielabel te vergelijken met degenen die het zonder hadden gekocht. Het energielabel bleek weinig invloed te hebben voorafgaand aan de aankoop. Slechts 10% van de energielabel-testgroep gaf aan dat het instrument van invloed was geweest op de koop van de woning, Hoofdzakelijk voor het besluit om de woning te kopen, gevolgd door een effect op de verkoopprijs, met in sommige gevallen een effect op de werkzaamheden die moesten worden uitgevoerd voordat de koper in de woning ging wonen. 22% antwoordde dat het energielabel hen had gestimuleerd tot het nemen van maatregelen ter bevordering van de energieprestaties na de aankoop. Er was geen statistisch significant verband tussen het hebben van een energielabel en het uitvoeren van energiebesparende maatregelen. Energielabel-ontvangers bleken vaker van plan te zijn om te investeren in toekomstige maatregelen voor energie-efficiëntie. De energielabel-testgroep woonde echter vaker in oudere huizen, wat ook een verklaring zou kunnen zijn voor dit resultaat. Een verschil op het gebied van de uitgevoerde maatregelen was dat energielabels-ontvangers vaker hadden gekozen voor muurisolatie en hernieuwbare technologieën.

Er werden problemen met de implementatie en een gebrek aan publieksvertrouwen in dit instrument vastgesteld. Meer dan 30% van de respondenten had een energielabel aangevraagd, maar dit niet ontvangen. Daarnaast had meer dan de helft van de niet-ontvangers geen energielabel aangevraagd, omdat ze dat niet nodig vonden.

Als energielabels ondanks de implementatieproblemen en de desinteresse toch werden aangevraagd, waren er wel enkele positieve effecten waar te nemen. 36% van de energielabel-testgroep zei het energielabel te zullen gebruiken als een richtlijn voor verbetering van de energieprestaties.

Net als bij de eerdere onderzoekscomponenten kwamen de nuances van de besluitvorming en niet-besluitvorming van huiseigenaren naar voren. Hoewel potentiële kopers zelden onderhandelden op basis van de energielabel-score, was een aanzienlijk deel van hen wel van mening dat energie-efficiëntie de waarde van een woning verhoogt. Evenals bij het maatwerkadvies kan worden geconcludeerd dat het energielabel niet zonder kritiek geaccepteerd wordt, want 50% van de aanbevelingen wordt genegeerd en een groot aantal maatregelen is uitgevoerd of gepland, maar nooit aanbevolen.

De beleidsinstrumenten van Europese koplopers

In deze onderzoekscomponent zijn de instrumenten die bepalend zijn geweest voor het handelen van verschillende Europese koplopers gekarakteriseerd en beoordeeld teneinde enkele 'algemene principes' voor instrumenten op dit gebied te vinden. In navolging van de eerste onderzoekscomponent is de beoordeling uitgevoerd met behulp van een set 'ideale' concepten als criteria, te weten:

- Combinaties van instrumenten.
- Evenwicht tussen verplichting en stimulering.
- Langetermijnprogramma.
- Doelgroepdifferentiatie.
- Voorrang voor energie-efficiëntie.
- Benadering van het huis als geheel.
- Toereikendheid van energie.

De instrumenten die bepalend waren voor het handelen in de voorbeeldsituaties waren opvallend verschillend. De Duitse aanpak was voornamelijk gebaseerd op subsidie, maar wel op een zeer ambitieus niveau. De Deense benadering draaide om wettelijke vereisten op natuurlijke momenten zoals renovatie. De Zweedse aanpak was een creatieve combinatie van subsidies en belastingen met een visie om de energielevering op de lange termijn te hervormen in de richting van hernieuwbare bronnen. In het Verenigd Koninkrijk golden verplichtingen voor energieleveranciers en werd hun 'netwerk' gebruikt om de eindgebruikers van de energie te bereiken.

Door de instrumenten te karakteriseren op basis van inhoud en effect werd geconcludeerd dat de instrumenten die in de gekozen voorbeeldsituaties het handelen bepaalden weliswaar enkele zeer innovatieve en effectieve elementen bevatten, maar dat alle benaderingen moeite hadden om voldoende hoge ambities voor energieombouw en participatie te realiseren. De beoordeling van de instrumenten volgens de voor deze onderzoekscomponent ontwikkelde criteria liet zien dan geen van de koplopers alle beleidsidealen op dit gebied wist te verwezenlijken. Bij alle benaderingen behalve de Britse, spelen vragen met betrekking tot de billijkheid een rol, vooral als het gaat om subsidies die aantrekkelijker lijken te zijn voor de rijkeren. De koplopers hadden hun instrumenten in het algemeen opgenomen in een langetermijnkader en gaven gemiddelde tot sterke voorrang aan energie-efficiëntie bij de ontwikkeling van instrumenten. Alleen in Duitsland werd in de kernbenadering sterk rekening gehouden met het perspectief van het hele huis. Duitsland en Zweden blonken uit in het creatief combineren van instrumenten. Het evenwicht tussen verplichting en stimulering was bij geen van de koplopers sterk aanwezig in de kerninstrumenten. Een vergelijkbaar resultaat werd gevonden voor instrumenten waarin de toereikendheid van energie is geïntegreerd. In dit geval was de aanpak van het Verenigd Koninkrijk het meest succesvol, want het was het enige voorbeeld waarin het hoofdinstrument, verplichting van de leverancier, regelmatig werd gecontroleerd om na te gaan of het energieverbruik daadwerkelijk daalde.

Slotconclusies en aanbevelingen

De resultaten van dit onderzoek wijzen uit dat er een enorme kloof is tussen de ambitie van het klimaatbeleid op internationaal, supranationaal en nationaal niveau en de hulpmiddelen die worden gebruikt om deze in de praktijk te realiseren. Op basis van de bevindingen van dit onderzoek kan worden gesteld dat deze kloof deels te wijten is aan het vrijwillige karakter van de beleidsinstrumenten en de verantwoordelijkheid van huiseigenaren voor het bepalen van een acceptabel niveau van energie-efficiëntie van hun woningen. Men zou kunnen zeggen dat het (vrijwillige) maatwerkadvies de hoeksteen zijn van het beleid ten aanzien van bestaande woningen en bouwverordeningen die op het gebied van nieuwbouw. Dit onderzoek toont echter aan dat meer dan 70% van de aanbevelingen van het maatwerkadvies wordt genegeerd. Uit enquêtes blijkt dat een van de belangrijkste redenen om niet te investeren in maatregelen voor energie-efficiëntie was dat huiseigenaren vonden dat hun woningen al energie-efficiënt waren. Hoewel in beleidstaal wordt gewezen op het belang van ‘transformeren van het woningenbestand’, ‘ingrijpende renovatie’ en ‘energieneutraal woning’, wordt het handelen in de praktijk bepaald door de perceptie die de huiseigenaar heeft van een energie-efficiënte woning, gesteund door vaak bescheiden en gefragmenteerde instrumenten als de huiseigenaren besluiten maatregelen te nemen.

De instrumenten worden gezien als bescheiden omdat subsidies en leningen doorgaans minimale financiële ondersteuning bieden voor eenmalige energiebesparende maatregelen. Tegelijkertijd zijn zulke instrumenten vaak sterk gefragmenteerd en verdwijnen ze meestal als het einde van de budgetten zijn bereikt. Informatie-instrumenten worden ook als bescheiden gezien, want er zijn maar weinig instrumenten die ingrijpende renovatie of innovatieve maatregelen en benaderingen bevorderen. Al het bovenstaande wordt als sterk bewijs gezien dat een serieus onderzoek naar de rol van een minimumnorm voor bestaande woningen nodig is.

Daarnaast zijn er meer permanente en innovatievere instrumenten nodig voor bestaande woningen. Het onderzoek naar koplopers bracht dergelijke elementen aan het licht. Op het moment van het onderzoek was bijvoorbeeld 40% van de leningen voor langlopende 'KfW Efficiency House' in Duitsland bestemd voor renovaties die verder gingen dan de eisen voor nieuwbouw. Gezien de ambitieuze doelen zouden de instrumenten ter bevordering van zulke prestatiegebaseerde en ambitieuze benaderingen de norm moeten zijn, maar ze blijven eerder de uitzondering dan de regel.

Instrumenten waarvan bekend is dat ze niet de gewenste resultaten opleveren vereisen serieus onderzoek. Dit geldt met name voor het energielabel en de energiebelasting. Manieren om ervoor te zorgen dat deze instrumenten betekenis krijgen voor huiseigenaren en om de vereiste veranderingen in het energieverbruik te bewerkstelligen zijn essentieel, vooral aangezien het ernaar uitziet dat deze instrumenten deel blijven uitmaken van het beleid.

Dat huishoudens met een hoog energieverbruik minder snel geneigd waren maatregelen te nemen ter verbetering van de energieprestaties levert een extra uitdaging op voor het ontwikkelen van een beleidsinstrument. Instrumenten die erin slagen huiseigenaren te stimuleren hun woningen en installaties te verbeteren, kunnen alleen echt van betekenis zijn als de huiseigenaren energie gebruiken op een duurzaam niveau. Een herziening van het energiebelastingstelsel om meer recht te doen aan het principe 'de vervuiler betaalt' kan een mogelijkheid zijn om het energieverbruik positief te beïnvloeden.

Uit de bovenstaande aanbevelingen op instrumentniveau volgt het advies om veel meer inzicht te krijgen in de huiseigenaren en de rol van instrumenten in hun besluitvorming. De resultaten in dit proefschrift en elders tonen de zwakheden van de barrière- en markthervormingsmodellen voor het ontwikkelen van instrumenten aan. Huiseigenaren en hun investeringsbeslissingen zijn ontzettend genuanceerd. In dit onderzoek is bijvoorbeeld geconstateerd dat huiseigenaren:

- Het grootste deel van de aanbevelingen in het maatwerkadvies negeren, zelfs als het advies zijn aangevraagd
- Vaak maatregelen nemen die niet zijn aanbevolen
- De waarde van energie-efficiënte woningen in het algemeen inzien, maar niet voldoende om energiebesparende maatregelen te nemen
- Zich er vaak niet van bewust zijn dat ze belasting betalen over hun energieverbruik
- Zich er vaak niet van bewust zijn dat hun energierekening lager is nadat ze energiebesparende maatregelen hebben genomen, zelfs niet als geldbesparing een motivatie was voor het nemen van de betreffende maatregelen.

Onderzoek wees uit dat er een diepgewortelde, maar ongenuanceerde beeldvorming is van beleidsinstrumenten en huiseigenaren en hun handelen of gebrek aan handelen als het gaat om het nemen van energiebesparende maatregelen. Op een basisniveau is er onvoldoende kennis van de uitvoering en het effect van instrumenten. Op een complexer niveau ontbreekt er kennis over de manier waarop instrumenten kunnen worden afgestemd op tegenstrijdige eisen aan hun prestaties, met name het bereiken van ambitieuze energieverbeteringen en een breed maatschappelijk draagvlak. Daarnaast is er onvoldoende inzicht in hoe de idealen van beleidsinstrumenten kunnen worden verwezenlijkt, zoals hoe instrumenten effectief kunnen worden gecombineerd en hoe ze daadwerkelijk kunnen zorgen voor een lager energieverbruik. Meer theoretische kennis over de instrumenten die de ambities van de wereldwijde klimaatafspraken kunnen verwezenlijken is een fundamentele vereiste als we willen dat bestaande woningen effectief bijdragen aan het halen van de doelen in Nederland en elders.

1 Introduction

§ 1.1 Background

§ 1.1.1 Climate change and energy efficiency

Energy use is an intensely publicised topic owing to the enormous challenges and controversies associated with its supply and demand. Related to this is climate change which basks in regular policy and media attention not least because of the predicted calamitous consequences for humanity if a 'business as usual' development model continues. It is widely accepted that greenhouse gas emissions such as CO_2 emissions from fossil fuel consumption are a major contributor to climate change (Carrington, 2016). At the same time, it is argued that anthropogenic impact on the climate can be influenced positively (ibid).

A further challenge in relation to energy use is energy security. Security concerns revolve around geopolitics and the anticipation that global supply of fossil fuels has peaked, or is close to peaking. Numerous other externalities are linked to the reliance on non-renewable energy sources. One is the ongoing destruction to the natural environment from fossil fuel extraction, supply and use resulting in air and water pollution, soil and groundwater contamination and habitat destruction. In a long shadow of energy security and climate change discussions is how many communities in developing countries are disenfranchised from their nation's energy resources.

The oil crisis of the 1970s injected urgency in finding efficient ways of extracting and using energy. A few decades later the realities of climate change added renewed impetus to the pursuit of energy efficiency (ibid). Concerns have culminated with ambitious national and international targets expounding greenhouse gas emissions reduction, increased share of renewable energy in the supply chain and improved energy efficiency. Efforts to reduce the extravagances associated with energy use include technological advancement and higher quality fuels as well as policy instruments such as international agreements, directives, regulations, financial incentives and disincentives and information campaigns targeting all sectors (Geller et al., 2006). This thesis is preoccupied with the role and impact of policy instruments

in meeting energy performance ambition in the building sector, in particular in the existing housing stock.

§ 1.1.2 Energy use in the building sector

The task of meeting targets is considered mammoth and requiring of full participation from all sectors. Participation of the building sector is a given with more energy use and more greenhouse gas emissions than any other sector in the European Union, with responsibility for 40% of final energy consumption and CO_2 emissions (EC, 2008). Potential savings are considerable. The European Commission argues that energy efficiency savings of 20% by 2020 are feasible. Studies demonstrate that it is possible to reduce final energy consumption in the housing sector by one third by 2050 (Amstalden et al., 2007). To propel policy action in reducing energy consumption in buildings the European Commission has developed two main items of legislation in recent years. The 2010 Energy Performance of Buildings Directive and the 2012 Energy Efficiency Directive set forth a whole host of requirements including energy performance certificates to be included during the sale and rental of buildings, minimum requirements during renovations and long term national renovation strategies.

Some EU Member States aim to achieve much more than what is set out at the European Union policy level. In the UK, there is a legal commitment to reduce greenhouse gas emissions by 80% by 2050 (Rosenow and Johnson, 2014). In Denmark there are plans for a fossil free economy by 2050 (DMCE, 2011, p. 8).

As well as offering the most scope per sector, the energy savings from the building sector are traditionally considered the most cost effective. The Intergovernmental Panel on Climate Change (IPCC) calculated that the building sector could achieve three times the emission reductions possible from other sectors and at a cost of approximately US$20/t$CO_2$ (cited in Lomas, 2010, p. 9). This means that the building sector could cover possible shortfall from sectors such as agriculture and transport where savings are considered less cost effective. It is further argued that with over 80% of energy used to heat space and water in existing houses gains can be very simply achieved by, for example, installing well established insulation products.

The future of the building sector in Europe is buildings with minimal energy requirements from non-renewable sources. In the European Union Nearly Zero Energy Buildings are to be the norm by 2020. However, it is buildings already constructed, the 'existing housing stock', that are key to revolutionizing energy use in the housing stock.

§ 1.1.3 Energy use in existing buildings

In most European countries, energy efficiency standards entered building regulations in the midst of the oil crisis of the 1970s with some Northern countries adopting measures over a decade earlier (Murphy, 2012). By today's norms these energy efficiency standards are minimal. Yet it is these buildings, constructed before or during weak energy based standards in building regulations that form the massive bulk of today's housing stock. This is laid bare by the statement that 80% of the dwellings that will make up the housing stock in 2050, the deadline for a host of energy targets in the building sector, have already been constructed (Ürge-Vorsatz, et al., 2007).

Within the building sector it is the residential building stock that forms the interest of this thesis. This is further narrowed to the private owner occupied stock, because:

- The owner occupied stock makes up the bulk of the residential stock in the Netherlands and across Europe and therefore holds significant energy saving potential,
- The owner occupied stock is disparate and not readily approachable through a regulatory structure such as is possible with the private and social rented stock in many countries. Therefore, developing instruments that can reach across this diversity in the absence of an organisational structure represents unique challenges.

Demanding significant cuts in the energy use of existing owner occupied dwellings invites a host of complexities and uncovers considerable problems. The natural trigger points are dwelling purchase and/or renovation. However, during the purchase phase energy efficiency is routinely overshadowed by the big players of location, cost and size and is commonly viewed as non-essential and alterable (Laine, 2011). Similarly, during renovation energy efficiency improvement commonly takes a back seat or is entirely ignored (Itard and Meijer, 2008, p. 23). Demanding action, inside or outside of these trigger points, in this very private sphere, is politically sensitive.

Another complexity surrounding energy performance improvement in existing dwellings is the lack of policy knowledge. Despite appearing on the radar since the energy crisis of the 1970s, this domain does not boast of a wealth of policy learning. Existing dwellings have never been strategically and systematically targeted in terms of overall energy performance improvement. Any scramble for new instruments uncovers a dearth of research and theorising on the kind of instruments that are suited to energy saving in the existing dwellings. Similarly, a call for revised instruments suggests research knowledge of tried and tested instruments. Tried yes but tested no, the most common instruments are associated with a remarkable lack of official evaluation. Evidence behind the assertions and assumptions associated with occupant behaviour and the mechanisms that drives the selection of policy instruments is similarly thin.

Herein lies the aim of the thesis: to add knowledge to the role and impact of policy instruments in meeting energy performance ambition in the existing housing stock.

§ 1.1.4 The Dutch housing stock

Most of the research presented in this thesis focuses on policy instruments designed to influence the Dutch existing housing market. The Netherlands counts over 7 million dwellings of which 70% belong to the private sector and 30% to the social sector. The private sector can be further divided into 60% owner occupied and 10% private rental. A correlation between income and the Energy Performance Certificate (EPC) rating is identified with the average rating for the highest income group a C and the average for the lowest income group an E. The housing sector in the Netherlands is responsible for 20% of final energy use and 17% of CO_2 emissions (Itard and Meijer, 2008, p. 15, Hamilton et al., 2010, p. 2).

§ 1.1.5 Dutch policy for energy saving in existing owner occupied dwellings

2020 targets for the Netherlands are a 20% reduction in greenhouse gas emission and a 14% increase in energy generation from renewable sources (MEZLI, 2011, p. 5). The Dutch approach to energy policy issues has been described as non-coercive and stimulative (Vedung and van der Doelen, 1998) which continues to be the dominant approach for existing housing, see Murphy et al 2012 (chapter 2). Targeting existing dwellings in particular presents a quandary as it is politically accepted as out of bounds for significant regulatory intervention (Hoppe et al., 2011). Furthermore, successive Dutch governments have promoted deregulation agendas into which more demanding instruments for the private housing sector do not fit snugly.

Consensus exists from national government and research communities that the Dutch building sector can be a significant contributor to meeting energy performance targets (Van der Waals et al., 2003; Van Bueren and De Jong, 2007; Beerepoot, 2007; Opstelten et al., 2007; Energy Transition Task Force, 2006; VROM, 2007; Vringer, Middelkoop and Hoogervorst, 2014). The debate gathers interest from different disciplines with technical knowledge of efficient technologies for existing dwellings from engineering and greater psychological understanding of the target group emanating from the social sciences. Public policy offers another angle to the debate and forms the interest of the thesis.

Some of the shortcomings associated with reaching targets are attributed to policy instruments. Beerepoot (2007) questions the strength of instruments charged with meeting targets, proposing more severe standards and more flexible instruments that reward performance above minimum standards. Brounen et al. (2010) and Van der Waals et al. (2003) claim that stronger regulations and/or financial incentives are required, particularly from a top down level. Vringer, Middelkoop and Hoogervorst (2014) argue for stronger norms and supporting instruments to overcome the shortfall of existing dwellings in meeting 2020 policy targets.

The Netherlands is not an exceptional case in the issue of whether targets can be met. Major European organisations routinely call for the rigorous application of existing instruments and the development of new measures to achieve ambitious pan European 2020 targets (OECD/IEA & ADF, 2008).

Note: research for this thesis was conducted several years ago with interview and survey data based on instruments available in 2011/2012. The policy landscape has slightly altered. Extra impulse for national targets is provided through the Energy Agreement (Energieakkoord). This agreement is between almost 50 organisations ranging from government, non-government organisations, consumer organisations, energy companies and branch organisations and the aim is to give greater stimulation to energy saving and renewable energy generation policies.

At the level of policy instruments, some tweaking of the EPC system resulted in the government issuing every household in the Netherlands with a temporary EPC in 2015. The idea is that during sale or rent a definitive EPC is then provided. At the time of research, no sanctions existed if EPCs were not available to prospective buyers and renters. Now a fine, up to a maximum, of €405 is imposed in cases of non-compliance. Several new financing mechanisms have come available. For example, energy saving loans are available through the National Energy Saving Funds, Homeowner Associations can avail of special energy saving loads and financing options are provided by mortgage lenders. Exemplar projects are promoted, namely, 'Zero on the Meter Renovations' (Null op Meter Renovaties) which demonstrate national ambition to reach an energy neutral housing stock by 2050. These above mentioned changes are not considered to affect the research questions presented in this thesis. The substance behind instruments such as energy audits, the EPC, subsidies and information tools available then and now remain the same.

§ 1.2 A policy instrument approach

§ 1.2.1 Policy instruments as a lens

A fundamental goal of this thesis is to deepen understanding of the content, mechanisms and scope of policy instruments. Peters and Pierre (2006) note that the selection of policy instruments may be the most important element in policy choice. Despite this: "[b]asic research questions remain unanswered, including which instruments are most likely to work, either singly or in combination, and how instruments interact both with public and private actors and institutions and with past policy choices" (Eliadis et al., 2005, p. 7). Fairey and Goldstein (2006) add to this critique claiming that "the purpose of almost all evaluations [i]s to measure the energy savings and cost….As a result, there has been almost no discussion in the global literature on energy efficiency about general principles…". Knowledge on the long-term effects of interventions is also scarce (Abrahamse et al., 2005).

Research on policy instruments is considered a sub-stream of policy research with links to policy formulations, design, implementation, change and learning, diffusion and transfer and governance (Voß, 2007). This so called instrument choice perspective seeks to understand policy formulation and implementation by following and examining policy instruments (Eliadis et al., 2005). Hood and Margetts (2007, p.12/13) note how "Government, like human beings themselves, is a tool-using animal…It is by applying its tools that government makes the link between wish and fulfilment". Policy instruments are noted as being relatively unexplored by academics often secondary or marginal compared to variables such as institutions or actors' interests (cited in Lascoumes and Le Gales, 2007). Eliadis et al. (2005) consider that taking policy instruments as the central unit of analysis is a practical and analytically useful approach. The value of taking an instrument based approach is emphasised by the statement "They give us a scale to measure the levels at which it is possible to debate the objects we need to work on" (cited in Lascoumes and Le Gales, 2007, p.18).

§ 1.2.2 Definitions and typologies

Policy instrument definitions engender a range of imagery based on tools, toolkits and mechanical solutions to defined problems. At a basic level policy instruments are defined as the concrete and specified operational forms of intervention by public

authorities (Bemelmans-Videc 1998, p. 4). Policy instruments have been described as "the art of finding solutions to policy problems that specify desirable relationships between manipulable means and obtainable objectives". Schneider and Ingram (cited in Birkland, 2005, p. 170) define tools as "elements in policy design that cause agents or targets to do something they would not do otherwise or with the intention of modifying behaviour to solve public problems or attain policy goals". James Anderson (cited in Birkland, 2005, p. 170) defines policy tools as "techniques of control that are by one means of another, overtly or subtly designed to cause people to do things, refrain from doing things or continue to do things they would otherwise not do. Stone (1988) on the other hand views the term instrument as misleading with the association of a mechanical fix. Instead she promotes a definition of policy instruments or solutions as "strategies for structuring relationships and coordinating behaviour to achieve collective purposes" (ibid: 208).

Lascoumes and Le Gales (2007) also diverge from the traditional definitions viewing instruments as institutions. In this case, institutions are understood as a more or less coordinated set of rules and procedures that governs the interactions and behaviours of actors and organisations. "Instruments really are institutions, as they partly determine the way in which the actors are going to behave; they create uncertainties about the effects of the balance of power; they will eventually privilege certain actors and interests and exclude others; they constrain the actors while offering them possibilities; they drive forward a certain representation of problems" (Lascoumes and Le Gales (2007, p. 9). Voß (2007, p. 64) also sets policy instruments within a wider policy framework seeing tools as "specifying institutional configurations and performances, including the steps that have to be taken to make them work" in this way tools "orient and coordinate collective attempts at shaping societal development by offering a concrete promise of control".

A voluminous range of literature focuses on policy tool typologies based on whether they incentivise, dis-incentivise, inform or/and build capacity. Popularised by Bemelmans-Videc et al. (1998) is a basic typology of 'carrots, sticks and sermons'. Depending on the country, sector or depth of study this typology can be expanded with a range of sub-sets. A typology adapted from Ürge-Vorsatz, Koeppel and Mirasgedis (2007, p. 460) is adopted in this thesis whereby tools are categorised as:

- Regulatory and control mechanisms
- Economic/market based
- Information and communication
- Support, and capacity building (covenants)

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§ 1.2.3 Instrument combinations

A truism in the field of policy instruments is that they should not stand alone but be combined with other instruments. That there is no one single policy tool that can encapsulate the scope and overcome the barriers of achieving energy performance improvement in this complex sub-sector is commonly asserted and captured by metaphors exhorting that there is no 'silver bullet', 'magic carpet' or 'holy grail' (Koeppel et al., 2007; Bressers and Huitema, 1999; Bertoldi et al., 2006). Instead the policy tool literature is characterised by words such as co-ordination, integration, optimality and synergy. Notions that policy mixes help maximise strengths and offset weaknesses with one policy tool stepping in to catch another's shortfall give promise that policy tool mixes are well orchestrated strategies perfectly aligned towards a single goal. Yet theoretical and practical guidance on what policy tool ingredients will form the perfect recipe is relatively unsophisticated. Examining tools combinations to isolate the type of tools that create synergy can lead an analyst into a 'tangled web' (Simões et al., 2005) where cause and effect are further blurred.

§ 1.2.4 The instrument target group

A focus of research presented here are owner-occupiers. The assumed behaviour of the policy target is a strong indicator of policy instrument choice (Birkland, 2005). Invariably the most prominent tools targeting existing houses lean towards the soft end of the legal spectrum with information and communication tools and subsidy schemes as paramount (Richardson, 2004). As a result, householders are typically incentivised rather than forced to improve the energy performance of their homes. This non-interventionist approach is encapsulated in the language of energy efficiency with associations of lower fuel bills, warmer and comfortable homes as opposed to the former language of energy conservation-with emphasis on reducing energy use (Owen, 1997).

The approach of appealing to householders to alter behaviour and offering advice and subsidies to alter building fabric is not without its critics. Gyberg and Palm (2009: 2010) note that "The battle for the future energy systems is in this sense made a consumer-orientated issue and it is the consumer who is expected to make the defining decisions leading to sustainability". Crompton (2008) states that focus on private sphere behavioural change is important cumulatively but there is a danger that this could lead to complacency. Furthermore, Crompton (2008) questions whether this approach will facilitate the required irresistible public demand for radical regulatory change. This so called 'small actions approach' is also critiqued by Retallack et al.

(2007 p 9) as "the language conveys ease, convenience and effortless agency. The problem with this approach is that it easily lapses into 'wallpaper' - the domestic, the routine, the boring and the too easily ignored".

§ 1.2.5 Conceptual frameworks for instrument design

The barrier model and market transformation theories are the frameworks in which most instruments in this domain are designed. Barriers or market failures related to, *inter alia*, inadequate information and lack of financing are frequently cited as reasons for the 'energy efficiency gap', the phenomenon whereby the adoption rate of energy efficiency measures fails to meet full potential (Jaffe and Stavins, 1994; Allcott and Mullainathan, 2010; Pelenur and Cruickshank, 2014). The barrier approach attracts a significant level of criticism. One is that a generic listing of barriers leads to a generic portfolio of tools that are expected to reach across the diversity characterising householders. Another is that tools are based on a rational and linear understanding of human behaviour, now widely regarded as defunct. Central to this argument is that current tools promoting energy performance improvement are based on one dimensional conceptions of human behaviour based either on economic rationality or green gadget consumer fetishism (cited in Collins et al., 2003).

A step further is viewing barriers as market barriers which can be removed by understanding the market and intervening effectively in a market transformation strategy (Geller and Nadel, 1994; Blumstein et al., 2000). Blumstein et al. (2000) defined market transformation as the policy objective of encouraging and inducing social, technological and economic change in the direction of greater energy efficiency. Market transformation sits neatly with the deregulation agenda pursued in the Netherlands and elsewhere as in theory at a certain point government intervention can be withdrawn with the market demanding energy efficiency dwellings. Geller and Nadel (1994) provide evidence of a successful market transformation strategy for appliances, with research and development, product labeling, efficiency standards and incentives interacting successfully to develop new technologies, inform consumers, eliminate inefficient products and stimulate consumers to purchase more efficient products.

§ 1.2.6 Reduction in energy consumption

Following a supposed successful policy instrument campaign and the adoption of energy efficiency and renewable energy measures by householders an obvious assumption is that predicted theoretical energy savings are achieved. Reviews suggest that most western European countries have experienced substantial reductions in energy intensity in the last 30 years (Geller et al., 2006). It is difficult to estimate the extent to which particular policy instruments are responsible for this reduction in energy intensity but some have 'clearly made a difference' (ibid: 568). Empirical research shows that identifying this 'difference' is remarkably complex (see Itard et al., 2008; Lockwood and Platt, 2009; Baird, 2009; Appelbaum, 2010). Lockwood and Platt (2009) analysed actual energy savings and modelled savings for households that underwent energy performance improvement measures. Modeled estimates explained approximately 50% of the variation in energy savings. The authors were careful not to denounce measures such as cavity wall and loft insulation accepted to have a major impact on the energy performance of a building but pointed to the importance of changes in lifestyle and consumer behaviour in relation to actual changes in energy use.

The variation among householder energy use can be staggering. Studies have found that in identical houses, with the same number of occupants, energy consumption differed by a factor of 2 (citied in Levine et al., 2009). Studies by Guerra Santin et al. (2009) and Majcen et al. (2015) concluded that occupant characteristics and behaviour significantly effect energy use casting major doubt on theoretical predictions of energy use which form the basis of many instruments.

The rebound effect adds further complexity to deciphering the energy use reduction which could be attributed to instruments. The rebound effect can be direct, in that improved energy efficiency leads to a decrease in price and therefore an increase in consumption (Dimitropoulos and Sorrell, 2006). Indirect rebound effects on the other hand result in increased consumption of another energy intensive service when lower prices are paid for energy services (ibid). The extent of the rebound effect is heavily contested some arguing that it reduces predicted energy savings by approximately 2-3% (Laitner, 2000, p. 471) while others claim that it can completely offset any predicted energy efficiency gains (cited in Dimitropoulos and Sorrell, 2006).

That householders may use savings accrued from improved energy efficiency for alternative energy related services demonstrates the difficulty with designing policy tools that truly trigger cross-sectoral lifestyle alterations. Findings relating to the true role and impact of instruments highlights the need to reconceptualise policy instruments as stepping stones (not end points) along a path seeking continual energy performance improvement.

§ 1.3 Thesis outline, research questions

In the section below the outline of the thesis is described per chapter. The main research question and sub-questions of each chapter are listed. It is the intention that these questions will allow the main research question of this thesis to be answered. The main research question is:

Do national policy instruments match policy ambitions to improve energy performance in the existing housing sector in the Netherlands?

Chapter 1: Introduction

Chapter 1 introduces the background of energy efficiency and climate change and the important role of the building sector for meeting targets in energy use reduction. Furthermore, the focus of the thesis on existing dwellings and the owner occupied sub-sector is explained.

An introduction to the theoretical background that influenced the thesis is provided with the focus on policy instruments explained. The conceptual background of instrument development including barriers and market transformation is described as well as key points about the owner-occupier target group. Vagaries attached to reaching the end point of actual energy use reduction are presented.

Chapter 2: An evaluation of household energy performance instruments in the Netherlands

As a starting point to understanding the instruments designed to improve energy efficiency in existing dwellings in the Netherlands a critical evaluation was undertaken using data from expert interviewees and published sources. A deficit and lack of clarity was considered to exist on how instruments and impact thereof are described and presented. Official documentation often gives the impression that instruments are successful and within range of targets with expected savings based on estimated take up of instruments presented in approximate figures (see for example National Energy Efficiency Action Plans as required under Energy Services Directive). However, a search behind simple facts and figures finds little depth to detail.

In an effort to overcome this shortfall an evaluation framework was created. The evaluation framework consists of steps from the theory-based policy evaluation method and fortified by adding normative concepts drawn from policy instrument and energy policy literature. All national energy performance instruments operating at the

time that could influence energy performance improvement in existing dwellings were included in the evaluation. Data was obtained from expert interviews with stakeholders involved in lobbying, designing, implementing and evaluating instruments. Interviewee data was complimented by secondary sources including evaluations of the national climate change programme, ad hoc evaluations of individual instruments, cross country evaluations and European projects in which the Netherlands participated.

Research question 1:

Are instruments, according to expert interviewees and published sources, sufficient to meet energy performance targets?

Sub questions:

- What was the content of current instruments?
- What theories were policy instruments based upon?
- Are current policy instruments achieving aims and objectives?
- Are pertinent policy instrument and energy policy concepts reflected in instruments?
- What can be deduced about the policy instruments used to meet national targets for energy performance improvement in the private existing housing stock in the Netherlands?

Chapter 3: Do energy performance policy instruments work on owner-occupiers?

A conclusion from the evaluation presented in chapter 2 was that the true nature and impact of instruments on the ground is often unknown. Expert interviewees commented that evaluations, if carried out, typically focus on user satisfaction without delving into whether the instrument stays true to its purpose. In fact, many of the assumed successes and/or failures of instruments were anecdotal.

In response to this knowledge gap a bottom up survey of owner-occupiers covering the same instruments as the evaluation in chapter 2 was conducted. The survey consisted of questions about energy saving measures adopted within the years preceding the survey focusing on measures involving significant investment to reduce space and water heating. The focus of the survey was the uptake of energy efficiency measures requiring considerable monetary investment, for example, insulation and micro-generation technologies. The questionnaire consisted of multiple choice and open ended questions divided into several categories; the adoption and planned adoption of energy saving measures, energy audits, the EPC, building regulations, the energy tax, financial incentives, information tools and socio-economic and dwelling characteristics. Data on motivations for energy use and perceived influences of instruments was also gathered. Both descriptive and statistical analysis was conducted on response data. Descriptive analysis focused on whether householders reported

an association between the adoption of energy saving measures and instrument use. Pearson's chi square tests were used to identify whether an association between adopting measures and instruments could be statistically proven.

Research question 2:

Is there an association between the use of national policy instruments and the adoption of energy saving measures?

Sub questions:

- Do instruments, according to survey respondents, influence the adoption of energy saving measures?
- Do instruments, according to statistical tests, influence the adoption of energy saving measures?
- Are household and dwelling characteristics significant for the adoption of energy saving measures among the sample?

Chapter 4: The influence of energy audits on the energy efficiency investments of owner-occupied households in the Netherlands

The broad range of policy instrument coverage in previous chapters was narrowed in chapter 4 to focus on energy audits. This information instrument emerges consistently as one of most popular for existing dwellings in both the Netherlands and further afield. As well as the most popular it is often heralded as among the most effective as it represents face-to-face advice tailored to a particular household's energy requirements. The aim of the research presented in this chapter was a deeper and more critical examination of the instrument beyond the assertions and assumptions associated with theory. This aim was met through use data from the survey conducted as part of the thesis and already introduced above.

Research question 3:

What is the role of energy audits in energy efficiency investment among owner-occupiers?

Sub questions:

- What was the influence of audits as reported by recipients?
- What was the association between recommendations made in the audit and those adopted and planned?
- What was the difference in energy saving investment between audit recipients and non-recipients?

Chapter 5: The influence of Energy Performance Certificate: The Dutch Case

Following a similar line of inquiry to chapter 4 the results and discussion in chapter 5 focus on an in-depth examination of the Energy Performance Certificate (EPC). The EPC became a requirement in 2008 for all buildings constructed, sold and rented in European Union member states. Among other things the EPC gives dwellings a rating based on energy performance ranging from A to G. For many years the EPC was heralded as a pioneering tool and crucial for the market transformation to energy efficient existing dwellings. A 'way in' to existing dwellings was found with this instrument with the requirement that it be made available at purchase and rental trigger points. The EPC became "arguably the most commonly available and accessible source of advice to home sellers and buyers about the sorts of improvements that could help save both cash and carbon" (NHER, 2009).

The aim of research presented in chapter 5 was to comprehensively assess the EPC in the Netherlands. It was possible to piece together a general view of how the EPC was functioning pre and post purchase from various research projects in different European countries. Research presented here differs as it not only focused in-depth on one country pre and post purchase but also exploits the lack of an enforcement regime in the Netherlands at the time of the survey by examining the differences in energy performance investment between householders with an EPC and those without.

Research question 4:

What is the role of the EPC pre and post dwelling purchase?

Sub questions:

- How did householders come to have or not have an EPC?
- What was the influence of the EPC as reported by recipients?
- Does statistical analysis show a difference in energy saving investment behaviour between the two sample groups?

Chapter 6: The policy instruments of European front-runners: effective for energy saving in existing dwellings?

To gain greater knowledge of the type of instruments associated with success in meeting climate change targets for existing dwellings, a comparative study of several front-runner countries was conducted. Denmark, Germany, Sweden and the UK were chosen as front-runners in this regard. As with chapter 2 an evaluation framework was developed specifically for this research component to tease out and deepen understanding of the content, mechanisms and scope of policy instruments. In this way, the search was for the general principles that could underlay energy performance

instruments instead of a traditional evaluation focus of savings and costs and strengths and weaknesses. 'Effectiveness' of instruments is interpreted in this chapter as both the documented results of goal achievement and the extent to which instruments deal with aspects unique to this policy domain.

Literature from comparative public policy was used to structure research for the first objective (Rose, 2001). This literature provided guidance on how to choose cases for comparative study. Document analysis was carried out to characterise instruments reported as effective. To meet the second objective, the main instrument(s) used by front-runners were assessed against concepts drawn from literature. Using concepts from literature is an effort to go beyond traditional 'strengths and weaknesses based evaluations by searching for how instruments tackle, or fail to tackle, salient issues in this policy domain. Results from document analysis and instrument assessments based on concepts were verified in phone interviews with national experts.

Research question 5:

How effective are the policy instruments of European front-runners for driving energy performance improvement in existing dwellings?

Sub questions:

- What instruments are considered as most effective in earning front-runner status for the chosen country?
- How can instruments be characterised in terms of content and effects?
- How do instruments perform against the assessment framework developed for this research component?

Chapter 7: Conclusions

In chapter 7 the findings are summarized with conclusions, limitations and recommendations presented and areas for further research discussed.

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2 A qualitative evaluation of policy instruments used to improve energy performance of existing private dwellings in the Netherlands

Abstract

Climate change policies in the Netherlands recognise the importance of existing dwellings. Efforts to gain these energy savings are led at national level by policy instruments such as the Energy Performance Certificate, covenants, economic and information tools. These instruments reflect a policy style described as consensus based and incentivising. However, this approach has been subject to criticism with suggestions that alternatives are required. As a first step towards conceptualising alternatives previous evaluations and stakeholder interviews are used to assess instruments. Elements from the theory based evaluation method combined with concepts from policy instrument and energy policy literature form an evaluation framework. Results demonstrate weak impact of some key instruments. Underlying theories associated with instruments are often lost during implementation or remain unsubstantiated. Policy instrument and energy policy concepts are evident but are far from pervasive. Results show that current instruments are poorly equipped to forge a long-term energy saving strategy for existing dwellings. It is further demonstrated that complexity with existing dwellings is not only limited to frequently cited barriers but to the intricacies of designing and operating a well-orchestrated instrument mix.

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§ 2.1 Introduction

The building sector and existing dwellings in particular are pivotal to meeting climate change policy targets in the Netherlands and elsewhere (BZK, 2011; McKinsey and Company, 2009; Ürge-Vorsatz et al., 2007). Nonetheless, existing dwellings are not

yet at the receiving end of the ambitious policy evident for new build, such as achieving 'nearly-zero' energy status by 2020. Instead incentivising and voluntarism appears to dominate policy for existing dwellings. The effectiveness of instruments based on this type of soft-law approach are often criticised or are not well publicised (Boardman, 2007; Hohne et al., 2009). Aggravating the situation are the barriers unique to this element of the stock. Barriers include the split incentive between landlords and tenants and difficulties with adequately informing householders about costs and benefits of energy saving measures. Overall, understanding of the type, scope and mix of policy instruments best suited to tackle demand side energy use in existing dwellings remains unsophisticated.

What is clear is that realising energy saving in existing dwellings that matches the estimated potential is complex. Hamilton et al. (2010) and McCormick and Neij (2009) are among those who note that ambitious targets fail to materialise into comprehensive strategies, effective instruments and transparent results. Secondary sources confirm the varying success of policy instruments in the Netherlands (Joosen et al., 2004; BZK, 2011; Noailly and Batrakova, 2010; Schneider and Jharap, 2010; Hoppe et al., 2011; Tambach et al., 2010; Beerepoot and Beerepoot, 2007). Meanwhile, recent quantitative analysis demonstrates that ambitious targets for the housing sector are not within reach (ECN, 2010).

Energy policy instruments for the Dutch housing sector have enjoyed some research attention. Attention has focused on energy transitions policy (Tambach et al., 2010; Kern and Smith, 2008), local government policies and policy requirements (Tambach et al., 2010; Hoppe et al., 2011) and the relationship between innovation diffusion and policy (Noailly and Batrakova, 2010; Beerepoot and Beerepoot, 2007). Attention to instruments steering action at national level and focussing solely on existing dwellings is under-researched. In response, research presented here aims to contribute to discussion on the characteristics of national energy performance instruments relevant to existing dwellings. A further aim is to create a baseline from which to conceptualise alternative instruments for the Netherlands.

To reach aims, national instruments operating during 2010 to improve energy performance of private dwellings in the Netherlands are analysed. The focus is instruments used to reduce energy consumed for space and water heating (approximately 70% of residential energy use in the Netherlands) (Itard and Meijer, 2008). Published evaluations and stakeholder interviews provide insight into three aspects adopted from the theory based evaluation method: instrument content, underlying theory and impact. In addition, results are discussed in terms of normative concepts taken from policy instrument and energy policy literature. The evaluation framework merges the theory of how instruments should operate with concepts that should guide instruments. This framework is considered to offer a deeper understanding of the actual functioning and ambition of instruments specifically

dealing with energy policy at dwelling level. In the next section the methodology is described in greater detail. The Dutch context in terms of features of the housing stock and policy is then provided. Next the results from the evaluation are presented followed by discussion and conclusions.

§ 2.2 Methodology

§ 2.2.1 Policy instruments and theory based evaluation

An approach to understand policy by taking the instrument as the 'unit of analysis' is supported by a number of authors (see Eliadis et al., 2007; Lascoumes and Le Gales, 2007; Howlett, 2004, 2011; Salamon, 2002). Salamon (2002, p. 602) describes the 'tools approach' as appreciating ''the characteristics of the available repertoire of tools and how they structure the play''. To evaluate instruments for this study a simplified version of the theory-based policy evaluation method was adopted. Firstly, instruments are characterised in terms of content as expressed in policy documentation or literature. Secondly, the policy theory associated with an instrument is described. Theories are understood as a set of coherent ideas that provide basis for an intervention (Weiss, 1997). Thirdly, the impacts of instruments are described, firstly based on secondary sources, followed by data from stakeholder interviews.

Theory based evaluation was adopted because of the insight it offers into how instruments operate. Harmelink et al. (2008) note how theory based evaluation establishes plausible theories on how instruments are expected to work and how they actually work in reality. The national instruments evaluated for this research were:

- Energy Performance Certificate
- Covenant: More with Less (Meer met Minder)
- Economic Tools
- Information Tools
- National Building Regulations

§ 2.2.2 Secondary sources and stakeholder interviews

Data on the impact of instruments was drawn from secondary sources including evaluations of the national climate change programme, ad hoc evaluations of individual instruments, cross country evaluations and European projects (in which the Netherlands participated). Secondary data originates from different time periods, utilises different methodologies, can sometimes be contradictory and never covers the complete range of instruments in operation. To complement secondary sources interviews were conducted with stakeholders involved in the lobbying, design, implementation, promotion and evaluation of instruments. Consensus based policy making in the Netherlands means that a wide range of stakeholder organisations are involved in the policy process. Their opinions were viewed as providing a window into whether instruments are having intended impact. In addition, given their influence on the decision-making process, stakeholders can illuminate what alternative or reformulated instruments could be placed on the agenda in the future.

Face to face semi-structured interviews were conducted over several months in 2010 and 2011 (see Appendix 1 for an outline of questions). Twenty-four stakeholder organisations were contacted, nineteen agreed to be interviewed[1] and several emailed data. Interviewees were selected to present an overall view of the topic while belonging to sufficiently different organisations (Rubin and Rubin, 2004).

Interview questions were designed to identify opinion on progress/problems with current instruments, areas for improvement, options for alternatives and the complete strategy for existing dwellings. To preserve anonymity reference is made to interviewees on the basis of their organisational affiliation (as highlighted in footnote 1). To avoid bias, results are only included if they converged across a number of interviewees from sufficiently different affiliations.

1 Government: Ministry of Interior and Kingdom Relations (BZK), Senate Office (Eerste Kamer der Staten-Generaal), Dutch Energy Agency (AgentschapNL), Municipality of Delft. Research: Energy Research Centre (ECN). Umbrella Organisations: Association for Home Owners (VEH), Association for Renters (Woonbond), Association for Housing Corporations (AEDES), Association for Estate Agents (NVM), Association for Installation Companies (Uneto VNI), Association for Construction Companies (Bouwend Nederland). Energy Companies: x2 (anon). NGO & Consumer Organisation: Stichting Natuur en Milieu, Milieu Centraal. Practitioners (organisations solely involved in design/implementation of instruments): the Housing Experiments Steering Group (de SEV), Meer met Minder (MmM), the Built Environment Energy Transition Platform (PeGO) and BuildDesk.

§ 2.2.3 Assessment concepts

Concepts from policy instrument and energy policy literature were used to further the evaluation. These concepts emerged frequently during a review of literature and are elaborated in the sections below. Concepts are:

- Policy instrument combinations
- Obligating/incentivising balance
- Long-term programme
- Non-generic
- Primacy to energy efficiency
- Whole house/deep retrofit
- Energy sufficiency

§ 2.2.3.1 Policy instrument combinations

Literature dealing with policy instruments emphasises that there is no 'silver bullet' or 'magic carpet' when it comes to instrument choice (Koeppel et al., 2007; Bressers and Huitema, 1999). Instead, it is widely accepted that combinations of instruments are required to deal with the complexities of many policy issues (Koeppel et al., 2007; Bressers and Huitema, 1999; Howlett, 2004, 2011; Gunningham and Sinclair, 1999).

§ 2.2.3.2 Obligating/incentivising balance

Combinations should favour a 'give-and-take-strategy' maximising the strengths and offsetting the weaknesses of individual instruments (Van der Doelen, 1998). This 'give-and-take-strategy' should combine restrictive and stimulative instruments to achieve effectiveness and legitimacy (Van der Doelen, 1998). The design of combinations to achieve an obligating/incentivising balance should consider the full range of instruments including regulations, voluntary agreements, information and economic tools (Bemelmans-Videc et al., 1998; Howlett, 2004).

§ 2.2.3.3 Long-term programme

Alongside notions of instrument combinations and a give-take balance is the longevity of instruments. Long-term policy programmes allow time for behaviours to shift and become embedded (EuroACE, 2010). A key factor in market transformation is that

long- term funding or supportive regulatory policies, but ideally both, are supported and sustained in effort over time until the market can sustain itself without public funding (Fuller et al., 2010).

§ 2.2.3.4 Non-generic instruments

Another strand of literature highlights the diversity reflected in the target group. Different housing types, construction periods, tenure, income levels and awareness characterise households. As well as physical aspects related to dwelling type and social and economic aspects, Guerra Santin et al. (2009), Caird et al. (2008) and Lockwood and Platt (2009) highlight how households can differ significantly in their perceptions of barriers, motivations for, and experiences with energy saving measures. Their research adds to criticism of generic instruments based on narrow conceptions of human behaviour.

§ 2.2.3.5 Primacy to energy efficiency

Another aspect is the approach to energy performance improvement promoted by an instrument. Instruments supporting micro-generation technologies irrespective of the energy efficiency of the thermal envelope can make further energy performance based renovation more expensive and less effective. Primacy to energy efficiency suggests a starting point of improving energy efficiency, followed by meeting energy needs from renewable sources and lastly obtaining, if necessary, energy from fossil fuels as efficiently as possible (Rovers, 2008).

§ 2.2.3.6 Whole house approach

As well as an order by which to approach energy saving there is discussion on the scope of current approaches. Some argue that ambitious climate change targets demand deep cuts in energy use requiring comprehensive whole house approaches, not single measures (Mlecnik et al., 2010). However, a whole house, or performance based approach, is novel for existing dwellings where promotion of single measures has traditionally dominated.

§ 2.2.3.7 Energy sufficiency

The goal and end point of instruments designed to improve energy efficiency is a reduction in energy use. However, sometimes implementation of the instrument becomes the end point. Wilhite and Norgard (2003) and Calwell (2010) coin the process where the end point remains true to final reduction in energy use as 'energy sufficiency'. This concept highlights the critical importance of adequate monitoring and evaluation programmes running alongside instruments.

§ 2.3 The Dutch housing stock

The Netherlands' 7.2 million dwellings are responsible for approximately 20% of final energy use and 17% of CO_2 emissions (Itard and Meijer, 2008, p. 15; Hamilton et al., 2010, p. 2). Approximately 20% of the housing stock predates 1945, 27% was constructed between 1945 and 1970, 32% between 1971 and 1990 and 21% since 1991[2]. Dwellings constructed before 1980 (and before 1970 in particular) are considered to hold significant potential for floor, wall and roof insulation (Itard and Meijer, 2008, p. 49). Double glazing and high efficiency boilers are displaying a successful diffusion rate with over 80% of dwellings containing double glazing in 2006 (BZK, 2010, p. 153; Joosen et al., 2004). Meanwhile, wall and floor insulation remain as considerable sources of saving potential (BZK, 2010). The Energy Performance Certificate (EPC), required under the European Energy Performance of Buildings Directive (EPBD), has become an indicator of the energy performance quality of the complete stock with a current average rating of D (BZK, 2010, p. 156).

Micro-generation technologies are diffusing slowly in Dutch dwellings with heat pumps forming approximately 0.5% of heating systems (Itard and Meijer, 2008, p. 53). Approximately 1% and 0.3% of the stock respectively use solar thermal technology and heat pumps to generate hot water (BZK, 2010, p. 154).

Housing tenure in the Netherlands is typically divided into private and social sector at approximately 70% and 30% respectively. The private sector is subdivided into 60% owner occupied and 10% private rented. The social housing sector is managed by private but non-for-profit housing associations. Owner-occupied stock is considered marginally more energy efficient than social housing and the private rented sector is

2 Database: Syswov 2009 ABF Research B.V.

considered the most inefficient. Over 30% of private renters reside in the worst rated dwellings (BZK, 2010, p. 154). A correlation between income and EPC rating has been found with the average rating for the highest income group a C and the average for the lowest income group an E (BZK, 2010, p. 161).

Between 1990 and 2008 total weather corrected household gas use decreased from 362 to 311 PJ (ECN, 2010, p. 42)[3]. Improved insulation and increased adoption of high efficiency boilers in existing dwellings are viewed as factors for this reduction (ECN, 2010, p. 42).

§ 2.4 Dutch energy policy for existing dwellings

2020 targets for the Netherlands are a 20% reduction in greenhouse gas emissions and a 14% increase in energy generation from renewable sources (MEZLI, 2011, p. 5). There is no target for energy efficiency (MEZLI, 2011, p. 5). These targets were issued by a government formed in 2010 and contrast with the previous government's more ambitious 2020 targets of 30% and 20% for greenhouse gas reduction and renewable energy generation respectively and a 2% reduction in energy consumption (VROM, 2007, p. 3). Despite a lowering of ambition, as reflected in targets, the current government supports a role for existing dwellings in reaching climate change goals (see BZK, 2011).

In terms of style the Dutch approach to energy policy has been classified as non-coercive and stimulative (Vedung and van der Doelen, 1998). Alongside this, existing dwellings in the Netherlands are considered immune to significant regulatory intervention (Hoppe et al., 2011). Legal questions surrounding property rights quickly quell policy discussions on the possibility of introducing obligations on householders to improve energy efficiency of their properties. Furthermore, successive Dutch governments have pursued a deregulation agenda and instruments entailing hints of undue bureaucracy and coerciveness are treated sceptically (see ENDS Europe, 2005 for the Dutch response to the EPC).

3 Gains from reduced gas use are offset by a continued increase in electricity consumption resulting in a steady overall increase in primary energy use in the household sector since 1990 (approximately 550 PJ) (ECN, 2010, p. 42).

§ 2.5 Policy instruments

In this section the main national instruments are described and evaluated in terms of content, underlying theory and impact. Impact is firstly described on the basis of secondary sources followed by results from stakeholder interviews. A summary is presented in Table 2.1.

§ 2.5.1 Energy Performance Certificate (EPC)

§ 2.5.1.1 Content of the EPC

Under the European Energy Performance of Buildings Directive an EPC is required at the sale and rental of a property. The EPC lists an energy rating for a building on an A–G scale. The EPC introduced in the Netherlands in 2008 was plagued with controversy ranging from presentation and methodological issues, an inadequate complaints procedure, issues surrounding accreditation of inspectors and the absence of an enforcement regime (VEH, 2007). The procedure was revised with a new EPC introduced in 2010. An official assessment concluded that the quality of the EPC has since improved (VROM Inspectie, 2010). Nonetheless, the EPC continues to operate as a quasi-voluntary instrument. The national ombudsman criticised the responsible authority for the way the EPC has been implemented (de Nationale Ombudsman, 2010). As a result of criticism, and requirements under the recast EPBD, there are plans to introduce an enforcement regime in 2012.

§ 2.5.1.2 Policy theory of the EPC

The main theory behind the EPC is drawn from EPBD text which states that lack of market demand for energy efficient dwellings perpetuates poor quality of the stock (EC, 2008). The use of a communication tool displaying energy efficiency and issuing recommendations for improvement is viewed as a market driver. The assumption is that consumers will act rationally in purchasing/renting a property if there is a perceived economic benefit (Gram-Hanssen et al., 2007). A second prong of the theory is that householders will act on the recommendations issued in EPCs.

Although not part of the original theory, manipulating the EPC to steer obligations, emerged as a discussion point in the Netherlands. In 2010, PeGO (a national platform of stakeholders formed under a previous government to find policy opportunities for existing dwellings) proposed policy packages which included a central position for the EPC. Different variations based on achieving an obligatory B rating over time were proposed with linkages to extant property taxes and supporting instruments such as low interest loans. The protracted formation of a new government in 2010 delayed further investigation of these proposals and PeGO was dismantled entirely in 2011.

INSTRUMENT	UNDERLYING THEORY	IMPACT
Energy Performance Certificate		
Displays the energy performance of a building. Required during sale & rental of properties.	Drives market demand for energy efficient dwellings	a)16% of sellers produced an EPC in 2010 (CBS 2011) b)2.7% premium for properties rated A, B or C (Brounen and Kok 2010) c)Majority of householders do not value EPC as a source of information (Adjei et al 2011)
More with Less Covenant		
Government & market parties work together to reach 2020 climate change policy goals in existing buildings. Short term goal: 20-30% 'additional' energy savings in 500,000 dwellings between 2008 & 2011	Shares responsibility among stakeholders towards achieving common policy goals. Anticipates, explores &/or supports regulation.	2008-2010 'additional' energy saving of 20% achieved in 314,000 dwellings (MmM 2011)
Economic Instruments		
Loans	Reduces financial barriers for households conducting energy saving measures	No formal monitoring & evaluation. Reportedly, low application rate with lower income applicants uncommon
Subsidies & VAT reduction	Incentivises 'additional' energy saving & diffusion of innovative technologies & renovation concepts	Contribution to More with Less covenant goals-no formal monitoring & evaluation
Energy tax	Enforces the polluter pays principle	Negligible influence on behaviour (BZK 2011)
Information tools		
Energy audit	Reduces barriers caused by lack of information	No information on adoption of energy saving measures following receipt of personalised information.
Web-based (interactive) Tools	Reduces barriers caused by lack of information	No information on adoption of energy saving measures following use of information tools.
Telephone & Email Advice - Consumer Organisation	Reduces barriers caused by lack of information	No information on adoption of energy saving measures following receipt of information.
Building Regulations		
Minimum standards during renovation/ extension. New building standards during complete renewal	Issues legal standards for energy performance in existing dwellings	Impact not evaluated but considered minor due to low ambition of standards & low replacement rate of stock

TABLE 2.1 Summary of national instruments, underlying theories and impacts

§ 2.5.1.3 Impact of the EPC

Published sources

The EPC is diffusing slowly in the Dutch housing market with 10% of sellers producing one in 2008 and 16% in 2010 (ECN, 2010, p. 42; CBS, 2011). There is as yet no official comprehensive evaluation; however, several research projects have explored aspects of the instrument theory. In terms of the theory of EPCs creating a market demand for energy efficient houses there are positive results. Brounen and Kok (2010, p. 7) found that EPCs demonstrate a ''moderately powerful market signal'' in the Netherlands with a 2.7% premium for properties with A, B or C ratings. A study casting light on the market demand theory from another angle shows weaker impact finding that 7% of Dutch respondents used the EPC as part of the property price negotiation (Adjei et al., 2011, p. A265).

The theory that EPCs impact on the decision making process of householders, motivating them to act on recommendations, enjoys less empirical testing. Following a trial of EPCs in the Netherlands, 3 out of a total of 62 householders stated their intention to carry out measures on the basis of the EPC (Hoogelander, 2006, p. 53). The small sample means that this result cannot be taken as representative. However, it highlights the lack of reliable information on this vital cause-effect aspect of the EPC. Another study found that only 28% of respondents found the EPC a useful source of information on improvements needed to reduce energy bills (Adjei et al., 2011, p. A277).

Interviewees

Interviewees generally lamented the 'false start' of the EPC in the Netherlands. A pervading view among these interviewees was that the revised EPC allows for the introduction of an enforcement regime. Interviewees, mainly from practitioner organisations, government and NGO organisations, see a role for the EPC beyond its original theory of creating market demand for energy efficient buildings to one, as suggested by PeGO, which could drive obligations by integrating EPC ratings to property taxation mechanisms. This is partly due to the considered ease of communicating EPC rating jumps to householders. An equal number of interviewees, mainly from umbrella organisations, support the EPC operating according to its original theory, believing that the instrument will increase in effectiveness over time as consumer confidence increases and an enforcement regime is introduced.

§ 2.5.2 Covenants

§ 2.5.2.1 Content of covenants

Covenants, or voluntary agreements, are a common instrument in the Netherlands embodying the cooperation and bargaining between government and stakeholder organisations that typifies Dutch environmental policy (Bressers and De Bruijn, 2005). In 2008, government ministries and umbrella organisations representing the housing and building sectors and energy companies formally agreed to share responsibility for climate change policy targets in existing dwellings by signing the More with Less (Meer met Minder) (MmM) covenant (MmM, 2009). Signatories to the covenant agreed to work together to create a permanent market for energy efficiency and to save 100 PJ of energy by 2020 (MmM, 2009). Targets include improving the energy efficiency of 2.4 million buildings by 20–30% by 2020 (500,000 between 2008 and 2011 and 300,000 dwellings annually from 2012 to 2020) (MmM, 2009).

An organisation has been formed to implement and manage MmM aims. The MmM organisation has, inter alia, developed an online 'one-stop-shop', an education programme and registration system for tradespeople (MmM Suppliers) and an MmM subsidy based on EPC rating jumps.

§ 2.5.2.2 Policy theory of covenants

The main theory behind covenants is that they share responsibility among key stakeholders dealing with policy issues (Bressers and De Bruijn, 2005). Published documentation assigns MmM a role of distributing national climate change targets to the main stakeholder groups (government, energy companies and umbrella organisations from the construction sector) and concomitantly stimulating a market for energy efficiency. A related aspect of the policy theory is that a covenant should not be considered as a substitute for regulation but should:

- Anticipate regulation.
- Explore the potential to change regulation.
- Support regulation.
- Prepare for the expected redundancy of regulation (Bressers and De Bruijn, 2005).

§ 2.5.2.3 Impact of covenant

Published sources

The MmM covenant is the only national policy instrument for energy efficiency subject to routine monitoring and evaluation. Monitoring reports note that private home owners are carrying out more energy saving measures in recent years. Between 2008 and 2010, energy savings of 20% additional to 'business as usual' were achieved in 314,000 dwellings (MmM, 2011). While it appears that on this basis, goals of achieving additional savings in 500,000 by 2011 will not be met it is considered positive in light of the economic crisis (MmM, 2011). The official evaluation of MmM highlights a mixed response from covenant signatories (Schneider and Jharap, 2010). Those from the construction industry appeared positive, pointing to a growing market interest in energy saving (Schneider and Jharap, 2010). Government signatories meanwhile reported a lack of confidence that goals would be reached (Schneider and Jharap, 2010). Reportedly, issues in terms of financing and a lack of clarity on responsibilities have overshadowed progress (Schneider and Jharap, 2010; Hamilton et al., 2010).

Interviewee sources

The majority of interviewees confirmed that MmM has suffered from a lack of commitment from signatories. A significant issue for many interviewees was the origin of the covenant as an alternative to a White Certificate Scheme, the result of a negotiation by energy companies. This is contrary to the policy theory that covenants should not be a substitute for regulation (Bressers and De Bruijn, 2005). Interviewees commonly discussed MmM as sharing a weakness with covenants in general; lack of sanction when commitment and action is lacking among signatories. On the other hand, interviewees were generally positive concerning the outputs of the MmM organisation such as MmM suppliers and the MmM subsidy which is issued on the condition that an energy audit (which includes an EPC) is obtained before energy saving measures are carried out.

§ 2.5.3 Economic tools

§ 2.5.3.1 Content of economic tools

Economic instruments active during interviews are listed below. Instruments are typical of what furnishes the portfolios of many countries such as subsidies, loans and fiscal instruments. Incentives listed below have a life of 1–2 years or earlier if budgets are exhausted. The energy tax forms the only long-term instrument.

- Energy saving credit: lower interest loans (approx.1%) for energy saving measures. Budget €35mln. Expected reach of 50,000 households.
- Green project loan: loans for micro-generation technologies and EPC rating jumps approximately 1.5% lower than market rates.
- Tailored advice certificate subsidy: a €200 subsidy (normal costs for a certificate ranging from €200-450). Budget €10mln . Expected reach 50,000 households.
- Micro-generation technology subsidy: covering solar water heating, heat pumps and micro CHP. Budget €40mln. Expected reach 15,300 households.
- Double glazing subsidy: €35 per m^2 of high performance glass. Budget €45mln. Expected reach 100,000 households.
- MmM subsidy: €300 for one EPC rating jump and €750 for two rating jumps. Budget €9.5mln. Expected reach 13,000 households.
- VAT reduction: 9-6% for labour and materials (with conditions).
- Energy tax: included in energy bill. VAT and energy tax comprise approximately 40% of bill.

§ 2.5.3.2 Policy theory of economic instruments

Theories behind economic incentives in use in the Netherlands include:

- Reducing financial barriers to carrying out energy performance improvements with subsidies and loans, with loans theorised as most helpful for low-income groups or starters on the property market (Blom, 2009).
- Supporting the diffusion of micro-generation technologies with subsidies.
- Incentivising householders to carry out 'additional' energy performance improvement during or outside normal renovation activity with subsidies and loans.
- Imposing the polluter pays principle/stimulating energy saving through the energy tax.

Alongside these theories, a number of instruments were introduced to assist the construction industry during economic crisis with concomitant gains for energy saving

expected namely, VAT reduction, energy saving credit and subsidies for double-glazing and tailored advice. Incentives were cost based with the exception of two performance based subsidies: the MmM subsidy based on achieving one or two EPC rating jumps and the Green Project Loan based on achieving four EPC rating jumps.

§ 2.5.3.3 Impact of economic instruments

Published sources

Hamilton et al. (2010) and Noailly and Batrakova (2010) conducted general evaluation studies on economic instruments in the Netherlands and discussed instruments as 'modest' and 'highly fragmented', critical of loans that offer only a 1% reduction on market rates and the 'stop–start' nature of incentives.

The energy tax was subject to assessment in 2004 when its impact was considered small at household level but high cumulatively (considering it is the only instrument applied to the complete stock) (Joosen et al., 2004). The government recently stated that the impact of the tax is viewed as minimal in terms of behavioural change (BZK, 2011).

Out of the four subsidies active in 2010 the MmM subsidy is the only one for which an evaluation could be found. Correspondence from the Dutch Energy Agency, which manages most of the subsidies listed in section 2.5.3.1, confirmed that subsidies are not evaluated besides at a user satisfaction level. The evaluation of the MmM subsidy highlighted findings in terms of cause and effect with approximately 33% of recipients surveyed (n=252) stating that they would have taken less energy saving measures, 20% would have postponed measures, 20% would not have taken any measures without the subsidy and 27% stated that it had no influence (MmM, 2010, p. 7). This shows that just under half of the recipients were free riders, householders who, at some stage, would have carried out the works without the subsidy.

Interviewee sources

Interviewees were unanimous in strong criticism towards the management of national subsidies, particularly, the stop start nature of subsidies. Interviewees from umbrella organisations and local government, involved in promoting subsidies to members and householders respectively, reported a lack of trust in national subsidies which can be unexpectedly withdrawn because budgets are reached.

Interestingly, few interviewees spontaneously mentioned the energy tax during questions on economic instruments. Interviewees almost unanimously viewed the energy tax as revenue rising and not a means of imposing the polluter pays principle.

Email correspondence was received from several financial institutions involved in Energy Saving Credit and Green Project Loan. One respondent from an institution holding a significant market share stated that lower income groups and property starters are not the typical applicants for energy saving credit loans. Others commented that use of loans is marginal with the main cause being a lack of awareness among the public. The organisation charged with administrating the Green Project Loan, the most ambitious instrument based of four EPC rating jumps, confirmed that in 2010 there was one applicant.

§ 2.5.4 Information tools

§ 2.5.4.1 Content of information tools

Information tools range from internet based tools, national TV broadcasts, the energy audit and dedicated inquiry services offered by the national environmental consumer organisation (Milieu Centraal). A large number of online tools offer information based on the input of data such as construction year, installations and energy usage. While the majority of information is generic, the energy audit scheme has been active in different forms for over a decade.

The MmM implementing organisation has sought to consolidate the range of information available from different sources. Alongside this consolidation exercise is the promotion of an online 'one stop shop' concept with information on energy performance measures, companies recognised as providing these measures (registered as MmM Suppliers) and economic incentives available to carry out measures.

§ 2.5.4.2 Policy theory of information tools

The asymmetry of information between householders and the energy efficiency possibilities in their dwellings (and resulting cost savings) is assumed to be the central policy theory behind information tools. That householders respond more positively to personalised information can be viewed as the basis behind tailored advice.

§ 2.5.4.3 Impact of information tools

Published sources

A number of reports have paid attention to the awareness of instruments and reaction to information but evaluation of actual activity following the receipt of information is lacking. Research shows that it takes time to embed awareness about the existence of instruments. In this regard, in 2009 18% of survey respondents knew about, or had used, an energy audit, a year later this increased to 23% (Schalkwijk and Mulder 2009, p. 9; Schalkwijk and Mulder, 2011, p. 14).

Relevant organisations report an increase in householders seeking information in the last number of years. Milieu Centraal witnessed a fourfold increase[4] in telephone and email enquiries between 2008 and 2010, questions on the double glazing and MmM subsidies were particularly frequent (Milieu Centraal, 2011). Less obvious is the number of recipients who go on to carry out energy performance improvement.

More is known about the impact of energy audits with an evaluation from 2001 to 2002 finding that householders with this instrument were more likely to carry out roof insulation, double glazing and install condensing boilers than householders without (cited in Joosen et al., 2004, p. 71). Results such as this show promise in the ability of this instrument in stimulating householders to carry out additional energy saving measures.

Interviewee sources

An interesting finding was that information tools were scarcely considered by interviewees in the overall strategy for existing dwellings. Interviewees commonly viewed information tools as representing a supportive role with a general opinion that this role is performed. Several interviewees noted that as most instruments rely on householders actively seeking information they may fail to reach a wider audience. Interviewees involved in MmM mentioned the intention of developing more active ways to engage householders in this regard.

Interviewees noted that their websites maintain a relatively constant number of hits which peak during campaign efforts. An interviewee from MmM noted that their website receives on average 3000 hits daily which increased to 4000 during a national

4 From 5400 in 2008 to 24,000 in 2010.

TV campaign. Similarly, interviewees from umbrella organisations noted that after special editions of member magazines or radio advertisements enquiries increased significantly. Interviewees confirmed that sustaining interest on a longer-term basis remains one of their greatest challenges.

§ 2.5.5 Building regulations

§ 2.5.5.1 Content of building regulations

The national building decree requires that during extension/renovation minimum requirements for thermal resistance are required for the new element while in cases of total renovation standards for new dwellings must be met. Local authorities implement building regulations in the Netherlands and do not have power to demand stricter or additional standards than those expressed at national level. The original EPBD requirement that minimum standards be applied during major renovation did not trigger an alteration to the regulation despite the absence of a formal definition of major renovation.

§ 2.5.5.2 Policy theory of building regulations

The policy theory of building regulations is interpreted as the setting of legal standards for design and construction relating to energy performance. In the case of existing dwellings, regulations can provide an opportunity to maximise energy efficiency improvement at the renovation trigger point.

§ 2.5.5.3 Impact of building regulations

Published sources

There is no official evaluation of the impact of building regulations on existing dwellings but considering the content of regulations impact can be considered minimal. Unlike some European forerunners, regulations in the Netherlands apply strictly to the part of the building undergoing alteration (see Engelund Thomsen et

al., 2009). The result is that innovative means of tackling existing buildings, such as consequential works (requiring energy performance to a whole building during renovation or extension) or requiring that a percentage of energy be obtained from renewable sources upon renovation/extension are absent. Influence from European level looks set to have the most significant impact on this instrument with the recast EPBD re-introducing attention to a definition of 'major renovation' and cost optimal minimum standards. The development of a standard in the next revision of the Dutch Building Decree, whereby new and existing dwellings can be compared, may facilitate discussion on a minimum standard for existing dwellings.

Interview sources

Interviewees typically considered the impact of regulations as negligible, yet few considered that this tool should have a greater role. A minority of interviewees, mostly from practitioner and government organisations, stated that regulations should be strengthened as a 'safety net' and at component level. Several interviewees considered legal barriers to forcing householders to carry out works in their property as a barrier. This is despite research finding that legal barriers are not insurmountable (see Groot et al., 2009). Instead interviewees largely remained dismissive of this traditional tool of government. Moreover, interviewees almost unanimously agreed that local authorities should not be permitted to set regulations. The main reason given by interviewees for this view is that national consistency is required for market actors.

§ 2.6 Discussion

§ 2.6.1 Content, theory and impact of instruments

Examining instruments in terms of underlying theory and impact illuminated that the objectives of many instruments are lost during implementation or are unsubstantiated. Examining the EPC in terms of underlying theories identified a paradox with higher rated dwellings obtaining a market advantage yet with the EPC performing poorly as a stimulus to improve energy performance. This confirms research from elsewhere that the impact of the EPC as a stand-alone tool in terms of driving energy efficiency is low (see Gram-Hanssen et al., 2007). It raises important questions about how the EPC can be made to play a more defining role in the actual energy performance improvement process.

Criticism about how the MmM covenant struggles to realise its fundamental theory of sharing responsibility among stakeholders overshadowed other theories associated with this instrument. Another theory is that covenants explore regulation. The MmM subsidy based on one or two EPC rating jumps provides the perfect evidence base for exploring the idea of rating jumps as a form of future obligation. In addition, the covenant plays a supportive role to the EPC with MmM subsidy recipients more positive about the EPC after the renovation process (MmM, 2010, p. 20). This shows that integrating the EPC with subsidies and/or directly with the energy performance improvement process through stimulating rating jumps could embed this instrument in a strategy for existing dwellings.

Examining economic incentives on the basis of underlying theories is severely hampered by the lack of evaluation conducted on these instruments. Correspondence from financial institutions reported that the theory that loans remove financial barriers for lower income households is not met because such applicants are uncommon. This raises questions on the equitability of current instruments and whether the divide already shown between the EPC ratings of dwellings and income is growing larger under the current policy instrument approach.

Moreover, incentives in use in 2010 were not designed to stimulate ambitious renovation levels neglecting the theory of incentives driving innovation. The most ambitious instrument was the Green Project Loan based on four EPC jumps; however, with only one applicant there are clear questions on whether it was adequately incentivising. The MmM subsidy represented the next most ambitious instrument with its performance based approach to one or two EPC rating jumps. Nevertheless, compared to a front-runner such as Germany, with performance based incentives aligned to bringing existing dwellings to, and beyond, new build standards, the MmM subsidy appears moderate in its ambition.

The energy tax, the only 'permanent' economic instrument, clearly falters in reaching its underlying theory of affecting behaviour, with acknowledgment from the government that it lacks effectiveness (BZK, 2011). Howlett (2011, p. 132) notes that taxes and incentives should be visible to order to ''promote virtues and discourage vice''. There is little evaluative evidence about whether the tax is visible for householders. Even if visible, householders have little ability to impact on it with renewable energy taxed and with little differentiation between user bands.

The most criticised aspect of economic incentives relate to the underlying theory of long-term market support. Interviewees were unanimous in their argument that instruments are too fragmented to create market stability and confidence. This corresponds with other research on the Dutch situation which found that the greatest need of (local) policy actors was stability of economic instruments (Tambach et al., 2010).

Information instruments stay true to their reputation as among the most difficult to evaluate (Vedung and van der Doelen, 1998). An increase in the search for information related to energy saving is reported. However, the role of available information instruments in decision making and whether action results from instruments remains poorly understood. Many information tools in the Netherlands are what Hood and Margetts (2007) term as 'packaged self-serve messages'. This form of instrument ''will only be effective if the prospective informees are sufficiently interested to want to help themselves to the packages on offer'' (Hood and Margetts, 2007, p. 37).

Lastly, building regulations make scant demand on the existing housing stock in the Netherlands and interestingly this was accepted by the majority of interviewees. This echoes the results of research by Tambach et al. (2010) that the incumbent renovation regime, with a lack of motivation to alter traditional renovation practices, forms a barrier to energy policy ambitions.

§ 2.6.2 Concepts

§ 2.6.2.1 Policy instrument combinations

As well as looking at the content, theory and impact of policy instruments, an aim of this evaluation was to establish if pertinent policy instrument and energy policy concepts are reflected in instruments. Elements of these concepts were identified but they do not permeate instruments or the approach.

While policy instrument combinations are in place this appears less to do with the development of an orchestrated strategy and more to do with different policy instruments being added to the mix. These additions are often the result of European legislation (the EPC) or overlapping policy aims (instruments introduced to assist the construction sector and concomitantly improve energy efficiency). While a coherent strategy of combined instruments does not characterise the approach there are examples of instrument interactions, for example, the MmM subsidy positively supports the EPC.

§ 2.6.2.2 Long-term programme

The majority of instruments operating in the Netherlands sit outside a formally connected long-term policy programme. This was a particular point of criticism for interviewees especially in terms of discontinuous and uncertain funding. Against the backdrop of strong criticism, the MmM covenant offers a long-term strategy, at least to 2020. Nonetheless, components such as the MmM subsidy remain temporary.

§ 2.6.2.3 Obligation/incentive balance

With a long tradition of incentivising in this sector it was hardly surprising that interviewees were deeply divided on the place of an obligation/incentivising balance in Dutch policy. Interviewees from government, practitioner and NGO organisations generally supported the introduction of a form of obligation typically revolving around the EPC and taxation mechanisms. The role of building regulations as a form of obligation received a general lack of support from interviewees, even during the critical renovation trigger. Similarly, there was a general lack of support for energy companies as a target group for obligations.

While half of the interviewees promoted the introduction of some form of obligation, an equal number, mostly from umbrella organisations, remain loyal to the incentivising approach. Interviewees promoting the incentivising approach again viewed the EPC at the helm but with improvements.

§ 2.6.2.4 Non-generic instruments

Several instruments recognise the need for a non-generic approach in terms of information provision, for example, the energy audit. However, beyond information provision, national instruments fail to integrate design elements to reach sub-groups like lower income householders and private landlords/renters. Moreover, given the lack of formal evaluation little is known about the characteristics of the householders that are reached by instruments.

§ 2.6.2.5 Primacy to energy efficiency

Primacy to energy efficiency is recognised in most instruments but is not fully integrated as subsidies for micro-generation technologies could be obtained regardless

of the energy efficiency of a dwelling. However, this concept is reflected in the energy audit, some loans and the MmM subsidy.

§ 2.6.2.6 Whole house approach

The concept of whole house retrofit receives some support from instruments like the MmM subsidy, which revolves around EPC rating jumps. With the exception of the Green Project Loan for four EPC rating jumps, no instrument specifically promotes the whole house concept at an ambitious level. Instead information instruments take the single measure approach to energy based renovation. While the whole house approach was widely supported by interviewees the associated complexity and resource requirement was considered a serious obstacle to promotion.

§ 2.6.2.7 Energy sufficiency

Based on literature and interviews the end point of instruments in the Netherlands appears to be their implementation. Whether the theoretical energy saving associated with instruments is realised and the types of householders who make use of instruments remain poorly understood.

§ 2.7 Conclusions

Elements from the theory based evaluation method combined with evaluations and stakeholder interviews were used to create baseline information on the policy instruments designed to improve the energy performance of existing private dwellings in the Netherlands. Objectives included gaining insight into the content, underlying theory and impact of the main national instruments and exploring how key concepts from literature are reflected in instruments. Research results provide a first step towards conceptualising improved instruments.

Possible improvements include a stronger EPC embedded in performance based incentivising programmes and in the renovation process. Experience with the MmM subsidy provides an evidence base from which to explore this further as may the experiences of how other European countries use the EPC. Reformulation of the energy tax to realign it to its theory forms an additional possible improvement.

The Dutch experience can form an important lesson for the development of instruments in this domain. On paper, a wide range of instruments have been used from covenants, incentives, taxes, information tools and regulation. However, examining instruments in terms of their characteristics, theories and impact and against concepts show that they fail to adequately 'structure the play'. Elements of concepts are clearly present but struggle to become fully integrated. Instead, most instruments appear and disappear over short periods, failing to form a combined and integrated strategy that consistently carries existing dwellings towards targets. What is more instruments typically dissolve with little contribution to empirical data about impact. The lack of monitoring and evaluation against the stated aims and goals of policy instruments is a serious weakness in the strategy for energy performance improvement in existing dwellings.

To further explore improvements to instruments alternatives and the link between instrument theories and impact, research into the precise influence of instruments on end-users is required. This could not only illustrate effectiveness but also aspects such as equity. Research into whether front-runners reconcile key concepts from policy instrument and energy policy literature could further assist with conceptualising the type, scope and mix of instruments suited to existing dwellings.

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3 Do energy performance policy instruments work on owner-occupiers?

Abstract

An urgency and necessity is associated with achieving the energy saving gains reported as languishing in the existing owner occupied housing stock. Success in this regard relies, in part, on the policy instruments in place. Many of the same instruments, including subsidies, audits and information tools, have been used for decades yet there is uncertainty and confusion about their impact. In response, bottom up data from a survey of owner-occupiers was used to evaluate the complete range of national instruments available in the Netherlands. Associations between adopting energy saving measures and using policy instruments were analysed. With the exception of the EPC, energy tax and energy saving loans, statistical tests found instruments to be associated with the adoption of energy saving measures. Information and financial instruments were described as the most influential. However, approximately 40% of respondents used instruments but did not consider them influential. While associations were found between instruments and adopting measures they were not at the transformative level that climate change policy demands.

§ 3.1 Introduction

The existing housing stock is reported to hold considerable energy saving potential. Space and water heating in these dwellings is responsible for 40% of the total energy consumption and greenhouse gas emissions in Europe (cited in Stieß and Dunkelberg, 2013, p. 250). Much of the stock is reported as 'leaky' constructed before energy standards made a significant entrance to building regulations. Commentators in turn argue for dramatic cuts in energy use and the research agenda is littered with calls for 'achieving zero', 'deep retrofit', 'transforming existing dwellings' and 'scaling up efforts' (Boardman, 2012; Curtain and Maguire, 2011; Delhagen et al., 2009). Accordingly, ambitious policy targets have been established reflecting both the urgency and scale of effort expected. In the Netherlands, targets of 20% reduction in greenhouse gas emissions by 2020 mean that 300,000 buildings annually should be improved by at least two energy rating classes (Ministry of Economic Affairs et al., 2014). To meet

targets in Britain "one building would need to be retrofitted every minute for the next 40 years…" (cited in Wilson et al., 2015, p. 12).

Meeting these ambitious targets relies, in part, on the policy instruments in place. A vast array of instruments has been designed to remove barriers to adopting energy saving measures that households are considered to face and to transform the market towards energy efficient products and dwellings. Many of these instruments have existed in various forms for decades. Despite the longevity of many instrument types there is uncertainty and confusion about impact, "despite all these inducements, instructions, prompts and prods, homeowners remain stubbornly resistant to improving their homes' energy efficiency by making structural changes to their heating systems, walls, windows, doors, lofts and basements" (Wilson et al., 2015, p. 19). This is part of the phenomenon termed the 'energy efficiency gap' whereby the adoption rate of energy efficiency measures fails to meet full potential (Pelenur and Cruickshank, 2014; Allcott and Mullainathan, 2010; Jaffe and Stavins, 1994). The energy efficiency gap is explained as "a complex phenomenon in which technical, institutional, market, organizational and behavioural factors all play a significant role and are interconnected" (Weber, 1997; Pelenur and Cruickshank, 2014).

Efforts to explain the gap between policy aspiration and reality are resulting in increasingly sophisticated lines of inquiry especially relating to socio-demographic and psychological factors of energy use and investment behavior (Abrahamse et al., 2005; Stieß and Dunkelberg, 2013; Scott et al., 2014; Pettifor et al., 2015; Risholt and Berker 2013; Bartiaux et al., 2014; Wilson et al., 2015; Frederiks et al., 2015). Lagging behind is sophistication in knowledge about the role of instruments. Research attempts to unravel instrument impact are plagued by methodological problems including small sample sizes, sample bias and the intractable issue of concluding causal impact in non-experimental research (see Alberini et al., 2014; Abrahamse et al., 2005; Frederiks et al., 2015). This is against a backdrop of little or no official monitoring and evaluation of policy instruments.

To add knowledge to the instrument dimension of the energy efficiency gap a framework was developed and used in Murphy et al. 2012 (Chapter 2) to conduct a top down evaluation of national policy instruments used in the Netherlands. A conclusion from this evaluation was that many unknowns surround the life of instruments once they leave the realm of policy makers and implementation authorities. Stakeholders interviewed for the top down evaluation lamented that instrument evaluations, when conducted, focused on user satisfaction and not impact per se. Many of the perceived successes and or failures of instruments were anecdotal. In response, this chapter uses bottom up data from a survey of owner-occupiers to evaluate the complete range of national instruments available in the Netherlands in 2012. The main question is: does an association exist between using instruments and adopting energy saving measures? In essence, do instruments work? As with the top down evaluation and all the research

presented in this thesis the survey focused on instruments aimed at reducing space and water heating in owner-occupied dwellings.

The survey consisted of questions about energy saving measures adopted within the years preceding the survey. Questions about all national instruments available to private owner-occupiers at that time were included. The survey also gathered data on motivations for energy use and perceived influences of instruments. Information about respondents was sought with questions about household and dwelling characteristics. This was to contextualize the sample and to control findings by comparing them to generally accepted findings in the field. Analysis, both descriptive and statistical, was conducted on data from over 5,000 survey respondents. Descriptive analysis centered on whether householders reported an association between the adoption of energy saving measures and the use of instruments. Pearson's chi square tests were used to identify whether an association between adopting measures and instruments could be statistically proven.

In section 2, the conceptual background and previous research that influenced this research including the formulation of the survey and subsequent analysis is summarised. In section 3, the methodology is described. Section 4 contains the results divided into:

- Contextual aspects relating to the quantity of measures adopted, motivations for adopting measures and reasons for not adopting measures
- Respondent answers about how instruments influenced them
- Statistical test results of associations between dwelling and household characteristics and the use of instruments.
- The associations between the use of instruments and the quantity of energy saving measures adopted.

Section 5 summarises the link between results and other research findings while in section 6 the conclusions and recommendations are presented.

§ 3.2 Background

§ 3.2.1 Policy instruments

Policy instruments have been defined as 'elements in policy design that cause agents of targets to do something they would not do otherwise or with the intention of modifying behaviour to solve public problems or attain policy goals' (cited in Birkland, 2005, p. 170). The expectation following this definition is great, instruments influence the target group so that government policy is pursued and reached. Progress reports and national plans typically give way to this definition presenting success stories of instrument take up and resulting estimated energy savings. Behind such stories lies a miasma. Do instruments play a role in triggering these savings? Do instruments have the intended impact? Do instruments urge householders to do more than they originally intended? Data that delves into these questions is severely lacking yet vital for a full and comprehensive understanding of household energy efficiency policy.

§ 3.2.2 Removing barriers and transforming markets

Policy instruments for improving energy performance of existing dwellings are typically developed from an analytical framework based on overcoming barriers and transforming markets (Blumstein et al., 1980, Wilhite et al., 2000; Weiss et al., 2012; de T'Serclaes 2007; Boardman, 2012; Wilson et al., 2015). The result is instruments designed to overcome information and financial barriers such as energy audits and subsidies. Instruments such as Energy Performance Certificates (EPCs) meanwhile are theorised as attaching an economic advantage to energy efficient dwelling thus transforming the market. The energy efficiency gap is often explained as a failure of instruments to adequately remove barriers (Weber, 1997; Blumstein et al., 1980, Wilhite et al., 2000; Pettifor et al., 2015).

The 'barrier model', on which many instruments are based, is heavily criticised. Conceptualizing householders as psychologically motivated individual decision makers is considered seriously flawed (Shove et al 1998; Collins 2003; Wilson et al 2015). Many researchers and policy advisors argue for a deeper understanding of the target group so that instruments can be designed more appropriately (Nilsson and Wene, 2011; Wilhite et al., 2000; Wilson et al., 2015; Frederiks et al., 2015; Rosenow and Sagar, 2015). The simplicity and problematic of the current system is

encapsulated in the statement of Frederiks et al. (2015, p. 576) "there is no single conceptual framework or model that is universally accepted by scholars as providing an all-inclusive explanation of energy consumption and conservation, nor any single approach that precisely predicts individual differences in such behavior".

§ 3.2.3 Energy saving investment in private owner-occupied dwellings-what is known

Previous research allows for a number of tentative generalisations about why households adopt energy saving measures and about household and dwelling characteristics that influence the adoption of measures. Research identifies particular types of energy saving investment that can to be broadly associated with household lifecycle and occupancy stages; results which form the basis for segmentation studies (Sutterlin et al., 2011; Frederiks et al., 2015).

Studies generally conclude that most householders take measures to reduce energy costs and to improve comfort (Bruel and Hoekstra, 2005) while the main reason for not taking measures is cost (Herring et al., 2007; Sardianou, 2007). Several studies identify links with income and the adoption of energy saving measures. Bruel and Hoekstra (2005) found that higher income groups were more likely to invest in measures to improve comfort with lower income groups investing to save money. The general conclusion from previous research is that higher income households invest in the energy saving measures while lower income householders curtail their energy use or take lower level energy saving measures (Pfaffenberger et al., 1983; Sardianou, 2007; Dillman et al., 1983). Exceptions do exist however with income found to be insignificant in the studies of Weiss et al. (2012) and Curtis et al. (1984).

Householder age is considered a common determinant of investment in energy saving measures. Sardianou (2007) found that as age increased the number of energy saving measures adopted decreased. Likewise, Hirst and Goeltz (1985) found that younger and older households take fewer actions than those of middle age. Meanwhile, Curtis et al. (1984) found that the 31-35 year age group carried out the most energy saving measures. Exceptions again exist with Weiss et al. (2012) finding that age had no influence on retrofitting.

Household size is considered another influence for energy retrofitting. Sardianou (2007) identified a link between increasing household size and number of measures adopted. Curtis et al. (1984) found that households with two to four people took a greater number of measures than other household sizes. Likewise, Herring et al. (2007) found two person households most active in energy retrofitting.

Less clear are the influences of education and occupation with some studies finding these are significant and others less so (see Weiss et al., 2012; Curtis et al., 1984).

§ 3.2.4 Policy instruments for saving energy- what is known

As opposed to research about household and dwelling characteristics, previous research is not sufficiently wealthy to allow for general statements about how instruments stimulate energy saving investment. Evaluations that exist are typically focused on single instruments and specific to the region of implementation (Adjei et al., 2011; Brounen and Kok, 2010; Gram-Hanssen, 2007; Rosenow., 2012). The dearth of evaluation that exists means that evidence is drawn from different countries with the caveat that design and implementation differences exist.

With this in mind it remains that the language of instrument impact is often negative, special loan schemes are reported to suffer from low take up, energy taxes as non-influential, subsidy schemes frequently criticised for significant numbers of free riders, information campaigns and instruments are said to reach the already interested and motivated (See Murphy et al., 2012 (Chapter 2); Murphy 2014a (Chapter 4); Murphy 2014b (Chapter 5); Joosen et al., 2004; BZK, 2011; ECN, 2010; CBS, 2011; Adjei et al., 2011; Hamilton et al., 2010; Wilson et al., 2015). Even best practice instruments like the federal loan and subsidy scheme in Germany is criticised for its 'tremendous remaining potential' (see Wilson et al., 2015), Murphy 2014c (Chapter 6). Meanwhile, flagship alternative instruments like the UK Green Deal are dismantled in infancy due to a lack of public appeal (Rosenow and Sagar, 2015).

§ 3.3 Methodology

To improve knowledge of the instrument dimension of the energy efficiency gap a survey was undertaken of Dutch owner occupiers in 2012. Out of the 7.4 million dwellings in the Netherlands, 55% belong to the owner occupied sector (Eurostat, 2015). Owner-occupiers are considered to have different requirements and experiences with policy instruments than social or private rented dwellings.

The survey included over 90 questions, mostly multiple choice with options for respondent input, pertaining to the use of instruments available at the time (see table 3.1 for the instruments that were included in the survey), the adoption of

energy saving measures and contextual aspects, for example, dwelling age and householder income. The complete survey is reproduced in Appendix 3 (translated to English from the Dutch original).

FINANCIAL	INFORMATION-ORGANISATIONS	INFORMATION	OTHER
Meer met Minder subsidy	Home owner association	Interactive web pages	Building regulations
Energy audit subsidy	Builders/installers	EPC	
High performance glazing subsidy	Meer met Minder organization	Energy audit	
Local/provincial subsidy	Environmental consumer organisation		
VAT reduction	Energy Company		
Energy saving loan			
Energy tax			

TABLE 3.1 Instruments forming part of survey

A focus of the survey was energy saving measures aimed at reducing space and water heating as these represent financial investment and are considered to contribute to long term reduction in energy use. The complete list of measures that appeared in the survey are listed below. These are the measures that appear as recommendations on the official national energy audit and EPC.

- Boiler replacement
- High performance glazing
- Roof insulation
- Floor insulation
- Wall insulation
- Heat recovery shower
- Heat recovery ventilation
- Insulation of piping
- Draught proofing
- Renewable technology
- Other

A key objective of the survey was to evaluate the EPC (see Murphy 2014b/Chapter 5), therefore, recent homeowners registered in the EPC database and recent homeowners registered as members of the Dutch Homeowners Association without an EPC were approached. Another objective, and one which forms the basis for the research presented here, was to explore and evaluate the effectiveness of the complete range of national instruments available to owner occupiers to reduce energy consumption for space and water heating. This scope sets this research apart from other evaluations

which typically analyse single instruments. The central research question is basic but crucial - is there an association between national policy instruments and the adoption of energy saving measures? Data from a total of 5071 owner-occupiers, either registered as holding an EPC or as a member of the national homeowner's association form the basis for this analysis.

Descriptive analysis of motivations for energy saving measures, funding, and the influence of instruments in the opinion of respondents was conducted. Statistical analysis of the association between the adoption of energy saving measures and instruments and householder contexts was also carried out. Given policy attention to the need for deep retrofit/adoption of several energy saving measures instead of 'one-off measures', analysis of the association between the quantity of energy saving measures adopted and instruments was conducted. Pearson's chi square tests were used to find statistical associations based on Field (2009).

Several representative issues were encountered with the sample (Eurostat, 2009; CBS, 2010 and 2012; CIA, 2012). Compared to the national average apartment dwellers were underrepresented as were one person households. Higher educated and higher income households were overrepresented while unemployed households were underrepresented. The majority of respondents belonged to the 40-65 age category. These representative issues mirror the sample bias which is typically encountered in this field (see Hirst and Goeltz, 1985; Stern et al., 1986; Wirtshafter, 1985; Abrahamse et al., 2005). A consistent finding in this research field is that instruments such as energy audits are used by higher income and higher educated older households with a greater interest in energy saving than is found in the general population. Socio-economic and dwelling data was collected to provide contextual information and as a means to check validity of data. Representative issues were not considered major and were not considered to impact on the research question therefore no measures were adopted to correct for this.

§ 3.4 Results

§ 3.4.1 Descriptive: Measures, funding, motivations and instrument influence

Of the 5071 respondents to the survey a sizable 3829 (75.5%) adopted an energy saving measure in the preceding four years. The norm was the adoption of one or two measures at 33% and 29% respectively. The most frequently cited reason for energy

retrofitting was to reduce bills, followed by improving comfort. Interestingly, while respondents were confident that comfort improved, just over half could confirm that energy bills had reduced. The explanation for this is not obvious. Perhaps respondents naturally choose saving money as a motivation from a list of multiple choice survey options but in reality it is not as strong as assumed by policy makers. This conforms with both old and recent policy critiques in which an over-emphasis on the financial aspects of energy saving to householders is highlighted (Magat et al., 1986; Wilson et al., 2015, Rosenow and Sagar, 2015).

Almost 40% of respondents who invested in energy saving measures spent over €4000, with savings the main funding source (in the case of 83% of respondents). Meanwhile, the main reason for not investing in energy retrofitting, 38% of respondents, was that dwellings were considered to be adequately energy efficient. This is considered an interesting result since the survey audit and EPC data show that in policy terms such dwellings would not be considered energy efficient.

Respondents were asked whether policy instruments influenced them in some way in their energy retrofitting and how they would describe this influence. 57% of respondents who used national financial instruments listed these as influential in adopting energy saving measures. The performance based Meer met Minder subsidy and renewable technology subsidy appeared most influential. Meanwhile, 60% of respondents who contacted national organisations about retrofitting described these as influential. 27% of respondents with an EPC/audit stated that this was an influential factor in their decision making while 16% of respondents who applied for a building permit described this as an influence.

The energy tax performed poorly in descriptions of its influence with 2314 respondents (46%) aware of the tax, of which 880 were able to estimate how much tax they pay of which, 178 stated it influenced them in some way in their energy use. Special energy saving loans showed a weak influence with 1% of the sample using one of the three loans then available.

To explore the influence and effectiveness of instruments in greater detail respondents who answered positively that instruments formed an influence in their decision making were asked three more detailed questions. In the case of information instruments, respondents were specifically asked whether the instrument influenced them to:

- adopt energy saving measures that they previously had not considered
- adopt measures because the instrument confirmed their ideas about energy saving measures
- adopt more energy saving measures than they had planned

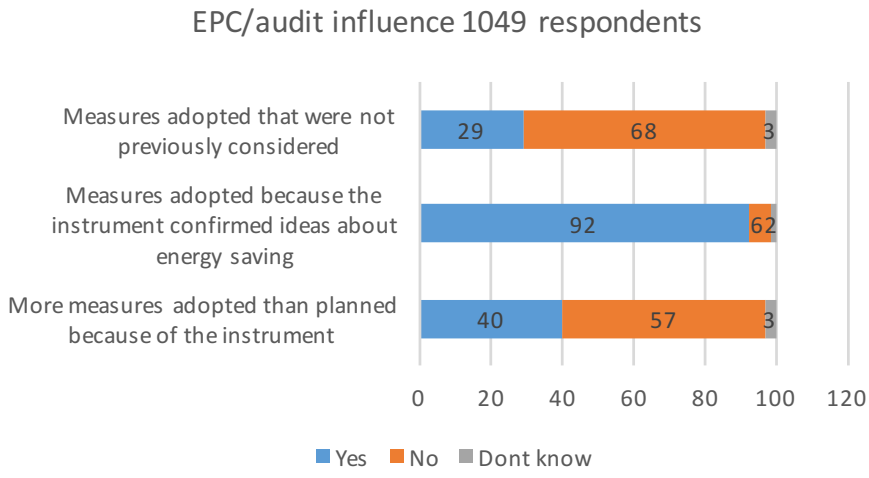

FIGURE 3.1 Influence of the EPC/audit

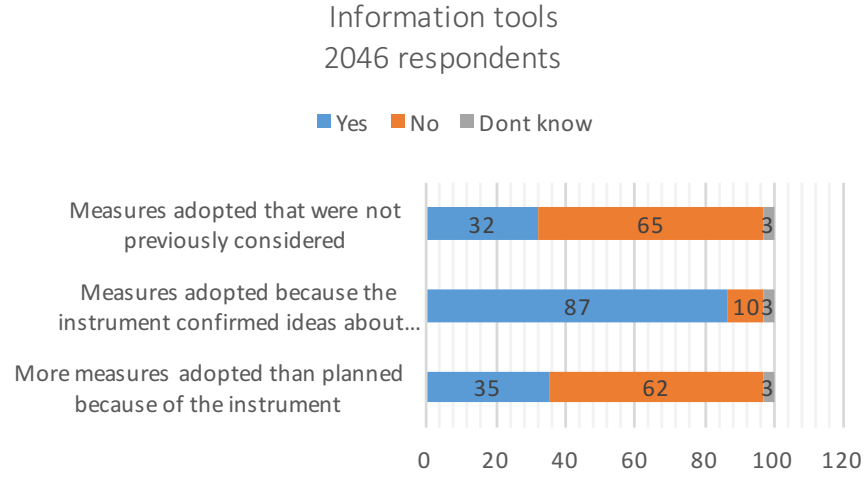

FIGURE 3.2 Influence of information tools

27% (1049) of respondents in possession of an EPC/energy audit stated that this formed an influence on adopting energy saving measures . 61.5% (2046) of respondents who contacted national organisations or used on online information tool stated that this formed an influence in their decision to adopt energy saving measures. The strongest influence of the information instruments was to confirm the information about energy saving already held by householders at 92% and 87% for the EPC/audit and general suite of information tools respectively, see figures 3.1 and 3.2. However,

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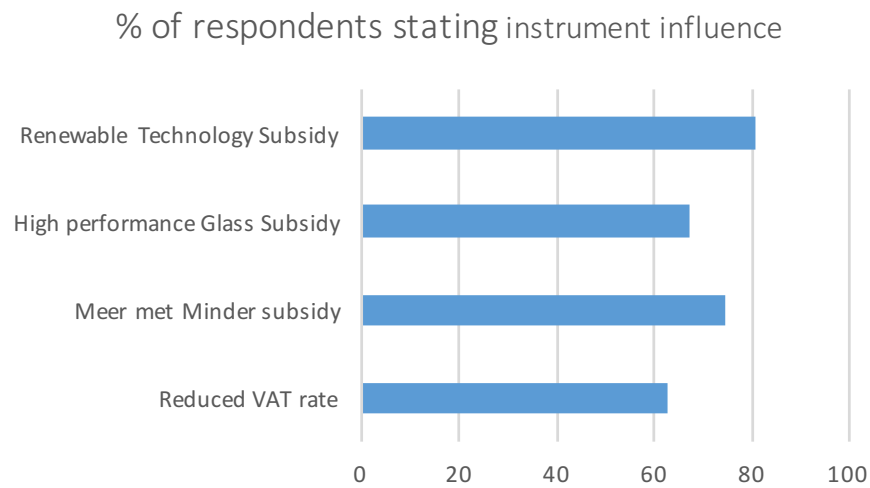
instruments were moderately influential at stimulating the adoption of energy saving measures that householders had not previously considered and at adopting more measures than originally planned. These results show some success of instruments at overcoming the barriers of inadequate and insufficient information.

In the case of financial instruments, respondents were asked whether:

- the instrument influenced them to carry out energy saving measures that they would not have carried out without the instrument,
- the instrument influenced them to carry out more energy saving measures than they originally planned because of the instrument
- the instrument influenced them to carry out measures earlier than they planned.

81% of respondents who used the renewable technology subsidy were positive about the influence and 74.5% of those who used the Meer met Minder subsidy found it to be influential, see figure 3.3. Meanwhile 67% and 63% of respondents who used the high performance glass subsidy and VAT reduction stated that this influenced their energy saving investment, see figure 3.3. The renewable technology and Meer met Minder subsidies appeared as the most influential financial instruments according to respondents, see figure 3.5 and 3.6



FIGUR E 3.3 Influence of financial instruments

The most influential aspect of all instruments was that they stimulated the earlier adoption of measures see figures 3.4 to 3.7. An important theory behind financial instruments is that they stimulate 'additional' energy saving improvement see Murphy et al. 2012 (Chapter 2). Instruments depicted above were moderately successful in this regard with the subsidy for renewable technology being the strongest at 60%. The renewable technology subsidy was most influential at stimulating the adoption of a measure that would not have been adopted without the subsidy, another important theory of financial instruments (ibid). The reduced VAT appears as one of the weaker financial instruments which confirms with this instrument being implemented primarily as a tool to stimulate the building sector more than an energy saving initiative per se (ibid).

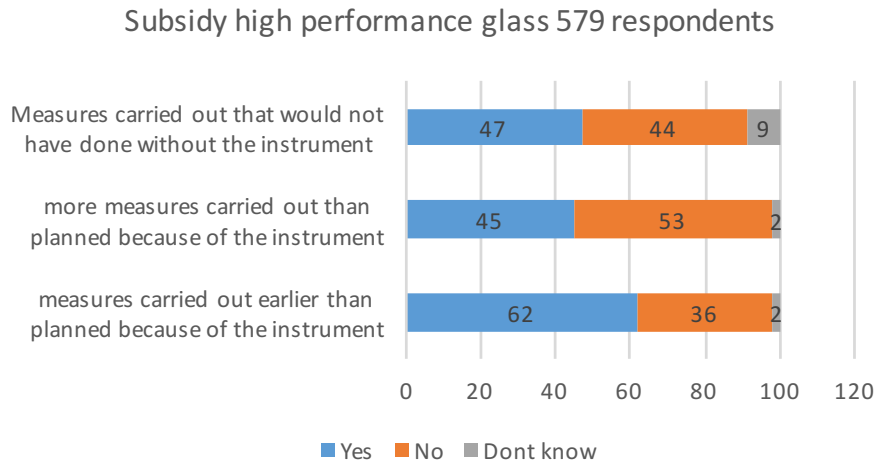


FIGURE 3.4 Detailed influence of glass subsidy

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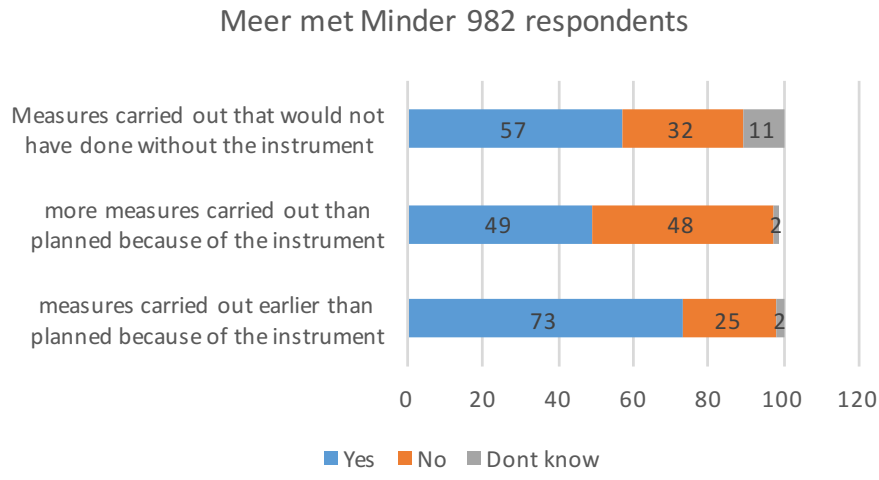

FIGURE 3.5 Detailed influence of MmM subsidy

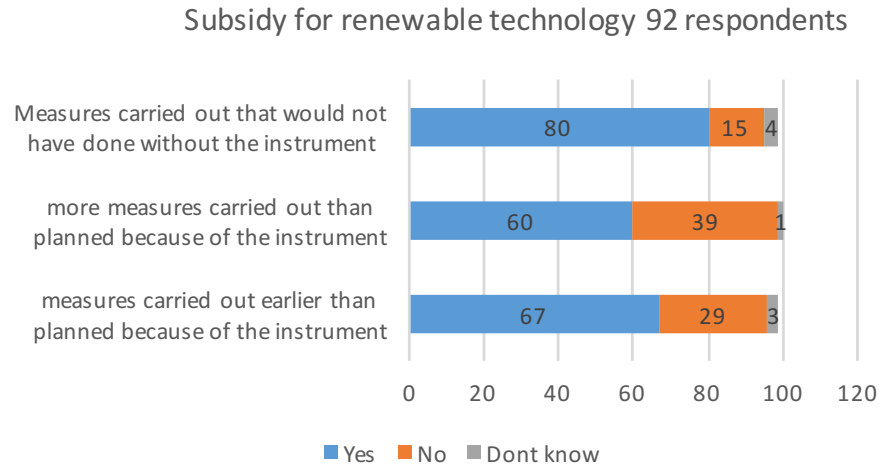

FIGURE 3.6 Detailed influence of renewable technology subsidy

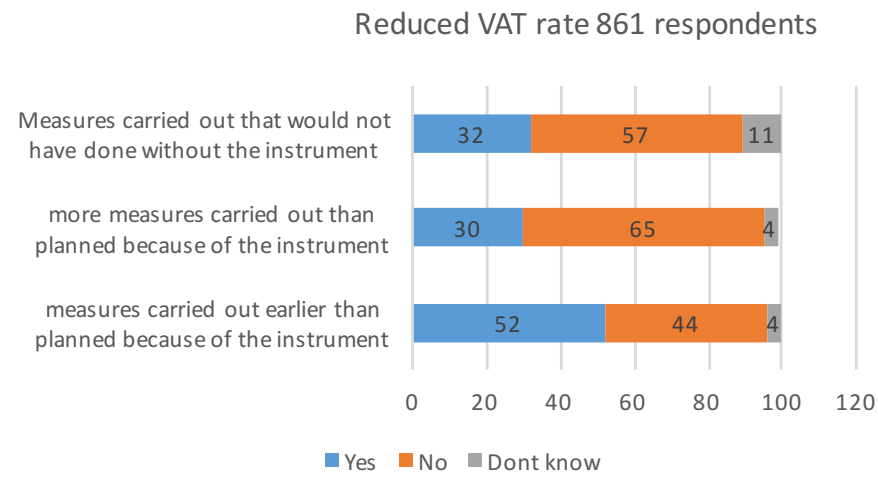

FIGURE 3.7 Detailed influence of reduced VAT

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§ 3.4.2 Statistical: Influence of dwelling and household characteristics on energy saving measures

Pearson's chi square tests showed that households living in detached dwellings were most active in adopting energy saving measures while those living in apartments and terraced dwellings were less active. An association between the age of the dwelling and the adoption of energy saving measures was identified with households living in older dwellings more likely to have adopted measures.

Meanwhile, results showed that one-person households were less likely to have adopted energy saving measures. An association between the age of the household and the adoption of measures was identified with the over 80s less likely to have adopted measures and the 40-65 age group more likely.

Households who lived in their dwellings for less than one year were less likely to have adopted energy saving measures and those with plans to move within a year were also less likely to have adopted measures. Interestingly, average, above average and high-energy users were expected to adopt measures more than they did although individually standardised residuals were not significant. No association between adopting energy saving measures was identified for the household characteristics of education, employment or income.

§ 3.4.3 Influence of instruments

Pearson's chi square tests were conducted to test for the association between adopting energy saving measures and using national policy instruments and information sources. A significant association was found for all instruments except for the energy tax and the EPC.

§ 3.4.4 Influence of dwelling & household characteristics on quantity of measures adopted

A further interest was to test the association between variables and the quantity of energy saving measures undertaken; measures were grouped into 3 categories: 1-2 measures, 3-5 and 6-9 measures. Analysis was run on the 3829 respondents who took some form of energy saving measure.

No statistical significant association was identified between dwelling type and the quantity of measures adopted. However, a significant association was identified between dwelling age and the quantity of measures adopted with dwellings constructed before 1945 more likely to be subject to 6-9 measures and dwellings constructed between 1945 and 1970 more likely to be subject to 3-5 measures.

Statistically significant associations were identified between most household characteristics and the quantity of energy measures adopted except for household education, income and energy use. Larger households were more likely to carry out more measures than smaller households and younger householders were more likely to carry out more measures than older households.

Households in full-time employment were observed to carry out more measures than expected while retired households were observed to carry out 1-2 measures more than expected. Households living in their dwelling for 1-5 years were more likely to carry out a greater quantity of measures while those planning on moving within 1-5 years were less likely to carry out greater quantities of measures.

§ 3.4.5 Influence of instruments on quantity of energy saving measures adopted

A statistically significant association was identified between the use of instruments listed below and the quantity of energy saving measures adopted:

- Meer met Minder subsidy
  (a performance based subsidy linked to the EPC rating)
- High performance glazing subsidy
- VAT reduction
- Building permit
- EPC
- Interactive web-pages

– Information from: the Home Owners Association, Builders/Installers, Meer met Minder and the National Environmental Consumer Organisation

The standardised residuals were statistically significant across all categories. The remaining financial instruments (subsidy for an energy audit, special loan and micro-generation technology subsidy) also showed that households who used these instruments were more likely to carry out more measures but standardised residuals were not always statistically significant across all categories.

The energy audit proved an interesting exception as a significant association existed but the opposite to that assumed i.e. households without an energy audit actually adopted 6-9 measures more than expected and households with an energy audit adopting 6-9 measures less than expected. Similarly, householders who made contact with their energy company were more likely to adopt 1-2 measures and less likely to adopt 3-5 and 6-9 measures. In this case the likelihood of adopting 6-9 measures was statistically significant.

§ 3.5 Links to other research

Results are largely in keeping with research results presented in section 3.2.3. Householder age and size were found to be significant for energy retrofitting but income was not. The lack of significance of income may be related to the sample selection consisting purely of owner-occupiers which is possibly more homogeneous than other survey results. As with other research results, education and occupation were not associated with adopting measures although householders with occupants in full time employment were found to carry out a greater number of energy saving measures. Energy measures were associated more with detached dwellings than apartments and terraced dwellings as well as with older dwellings.

As with other research the main reasons for carrying out energy saving measures were to reduce energy bills and to improve comfort. The main reason for not carrying out energy saving measures was that dwellings were considered energy efficient. This diverged from the cost barrier which is the most frequently cited reason from other research.

Results largely mirrored the top down evaluation presented in Murphy et al. 2012 (Chapter 2) and research in this area. The energy tax was found to have little influence both according to respondents and statistical tests with less than half of the sample even aware of its existence. Likewise, energy saving loans were not popular with use

of individual loans too low for statistical analysis. Similarly, the criticisms of the EPC by stakeholders were supported by the survey results showing that this instrument was not associated with the adoption of energy saving measures with a low 27% of respondents describing the EPC as an influence.

Some divergence from the top down evaluation presented in chapter 2 was found with information tools. These instruments were scarcely considered by stakeholders in the overall repertoire of tools promoting energy efficiency. However, contact with national organisations promoting energy efficiency emerged as one of the most influential instruments from the household survey with 60% of householders describing this as an influence in their energy efficiency investments. This positive result points to the opportunity that these information sources hold to promote deep retrofit and raise awareness of other instruments. An exception was contact with energy companies which was not associated with deep retrofit.

Another exception to previous research and to results from the top down evaluation was that the energy audit was found to deviate from its intended impact of influencing deep retrofit. Householders in possession of this instrument were found less likely to carry out an increased number of measures. This finding may have some relevance to the finding of Frondel and Vance (2012), that recipients decide not to invest in measures on the basis of audit information, especially if investment cost is 'over emphasised' (Magat et al., 1986).

Research results support findings that promote performance based subsidy schemes (Rosenow and Sagar, 2015). The Meer met Minder subsidy with a link to the energy audit was the only performance based subsidy available at the time of the survey and relative to other subsidies it showed positive results. As shown in figure 3.5, 57% of respondents who found the instrument influential would not have carried out energy saving measures without the instrument and 49% carried out more measures than they planned because of the instrument.

§ 3.6 Conclusions and recommendations

The central research question of this research component is: does an association exist between the use of national policy instruments and the adoption of energy saving measures? Statistical tests show that the majority of instruments available to owner-occupiers at the time of the survey were associated with the adoption of energy saving measures. Notable exceptions were the EPC and energy tax. When respondents were asked directly about the influence of instruments information sources appeared the

most influential at 60% followed closely by financial instruments at 57%. While these percentages represent a majority in both cases they are not overwhelming. Therefore, a large portion of the sample used instruments but considered them of weak or no effect. The title of this chapter asked "do energy performance policy instruments work on owner occupiers" the answer, yes, but not at the level of 'transforming', 'achieving zero' or 'deep retrofit' that climate change policy and targets demand.

Research results highlight the need for a more sophisticated framework for the development and design of instruments that goes beyond the barrier and market transformation models. Models that truly understand and capture the behavior of householders is required. This is evidenced in this research by the many nuances surrounding household investment behavior such as the fact that the main reason for not retrofitting among survey respondents was not a typical barrier but an understanding of adequate dwelling energy efficiency. The behavior of householders in actual energy use is garnering greater attention in research and policy. The actual rather than theoretical behavior of householders with policy instruments is equally in need of greater attention. It is the decisions of householders that will determine whether energy saving targets will be met and yet a wealth of nuances and unknowns surround these decisions.

Results from here and other research strongly suggest that a rethink is required about the instruments used to promote energy efficiency among owner-occupiers. "The understanding shared by policy makers and practitioners of how energy efficiency can and should be improved is deeply institutionalized, and continually reproduces similar portfolios of policies" (Wilson et al., 2015: 19). This statement rings through for research presented here. Many of the same information tools and single stand alone subsidies, taxes and loans continue to form the main policy response to meet climate change targets. Research here shows that the influence of single stand alone instruments is much weaker than a performance based subsidy linked to an information instrument, for example the difference between the high performance glass subsidy and reduced VAT rate compared to the Meer met Minder subsidy. Many of the findings from research presented here support the policy recommendations of Boardman (2012) and Rosenow and Sagar (2015) that regulatory standards may have a role to play in the owner occupied stock. Rosenow and Sagar (2015) suggest eliminating the lowest energy rated dwellings with a gradual increase in standards. Results from this research that high energy users were also reticent in adopting measures suggest that the regulatory arm could extend to energy use perhaps through a properly functioning polluter pays energy tax.

Research presented here hints at the variety and complexity of inter-relating factors that come in to play in a householder's decision to invest in energy saving measures. Research is adding knowledge to these factors constantly. There remains however much scope for further investigation and deeper analysis of these factors. Further

research could examine the extent to which policy instruments were decisive in adopting energy saving measures. Many respondents to the survey used in this research component consented to be contacted for future research. The scope herein is great including the possibility to conduct face to face interviews with householders to gain greater understanding of their action and experiences. Deeper analysis of the inter-relationships between instruments and variables will enrich understanding of the energy efficiency gap and methods to close it.

Within such a robust long term policy strategy there would need to be a secure place for a sophisticated means of monitoring and evaluating instruments. Results showing that the energy audit among this survey sample was not associated with deep retrofit points to the need for constant evaluation to ensure that instruments remain true to their intended consequences and to understand the factors at play if they are not. That many instruments included in this survey were rehashed versions of instruments that have been operating for decades in the western world with questionable results shows some serious flaws in this policy domain. A culture of robust evaluation could improve this.

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4 The influence of energy audits on the energy efficiency investments of private owner-occupied households in the Netherlands

Abstract

Energy audits are promoted as an effective tool to drive investment in energy efficiency measures in the residential sector. Despite operating in many countries for several decades details of the impact of audits are mixed. The aim of research presented here is to explore the role of audits on investment in energy efficiency measures by private owner-occupied householders in the Netherlands. Results showed that the main influence of the energy audit was to confirm information held by householders. A significant portion of audit recommendations was ignored, the main reason being that householders considered their dwellings to be adequately energy efficient. A comparison of audit recipients to non-recipients showed that audit recipients did not adopt, plan to adopt or invest in more energy efficiency measures than non-recipients. In fact, non-recipients adopted more and invested more in measures. It is concluded that energy based renovation is driven by householder perception of comfort and acceptable outlay on energy bills and not necessarily to expert technical tailored information on the potential to reduce CO_2 emissions and environmental impact. Results support arguments for minimum energy efficiency standards and performance based incentives.

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§ 4.1 Introduction

Climate change policy gives existing dwellings a key role in reducing greenhouse gas emissions by 20% by 2020 and 50–80% by 2050 (EC, 2011). In quantity and quality terms there is considerable scope in existing dwellings for energy efficiency

improvement. The European Commission (EC) (2006a:5) estimates a cost effective potential to reduce energy use by 27% in the residential sector primarily through measures such as roof and wall insulation. Moreover, it is stated that energy savings can be achieved in existing dwellings more cost effectively than any other sector (Levine et al., 2007; Ürge-Vorsatz et al., 2007). Alongside meeting climate change targets there are multiple positive spin-offs, such as, reduced household expenditure on energy bills, improved occupant health, reduced dependence on non-renewable fuels and protection of environmental resources. However, despite the much lauded benefits a considerable gap between estimated energy saving potential and reality persists (Blumstein et al., 1980; Jaffe and Stavins, 1994; Weber, 1997; Curtain and Maguire, 2011). There are a number of explanations as to why householders do not invest in energy efficiency measures. One explanation is that they do not have adequate information to assess options and potential savings (Gates, 1983; Schleich, 2004; Löfström and Palm, 2008).

A range of policy tools are considered capable of overcoming this information deficit. Promoted as one of the most effective is face-to-face advice that is tailored to a particular household's energy requirements and dwelling characteristics (Gates, 1983; Stern, 1992; New Perspectives 2002; Benders et al., 2006). Energy audits are endorsed by organisations such as the IEA, the OECD and the EC (OECD, 2003; EC, 2006b; OECD/IEA, 2010). The EC urges Member States to establish programmes for audits: "In order to realise the energy savings potential in certain market segments where energy audits are generally not sold commercially, such as households, Member States should ensure the availability of energy audits" (EC, 2006b, p. L114/66).

However, despite the endorsement and theoretical assumptions about cause and effect there is a little empirical data that proves if energy audits function as intended. This knowledge gap is not unique to energy audits but is pervasive for policy instruments designed to improve household energy efficiency. For several decades, researchers have bemoaned the lack of systematic evaluation of instruments and the consequent lack of understanding about the true nature of barriers, the overall effectiveness of instruments and general principles underlying the formulation of instruments (Blumstein et al., 1980; Jaffe and Stavins, 1994; Fairey and Goldstein, 2006; Lowe and Oreszczyn, 2008; Maio et al., 2012).

In response to this research gap an extensive survey of Dutch households was conducted in 2012. The main aim of the survey was to examine the energy efficiency measures adopted and planned by households and the awareness, use and influence of different policy instruments on their action and plans. The focus of the survey was the uptake of energy efficiency measures requiring considerable monetary investment, for example, insulation and micro-generation technologies. These measures hold the most potential to reduce energy use for space and water heating (accounting for over 70% of residential energy use) (Itard and Meijer, 2008). The survey was limited to

homeowners as this represents the single largest share of the housing market in the Netherlands and is therefore considered to represent the largest possible savings[5] . Furthermore, the instruments developed for owner-occupiers are distinct from those aimed at social and private landlords for which it is considered separate surveys would be more appropriate.

One objective of the survey was to identify the impact of energy audits. This objective was reached by (a) analysing the influence of audits as reported by respondents and (b) analysing the difference in energy efficiency investment behaviour between audit recipients and non-recipients. In the next section the theoretical background is outlined followed by an overview of previous research. The survey design and statistical tests adopted for analysis are presented in Section 4. Results are presented in Section 5 and in the last section results are discussed and recommendations are proposed.

§ 4.2 Theoretical background

§ 4.2.1 Barriers and information

The barrier model is typically used as a basis for the development of instruments. Along with financial constraints, lack of time and hassle; lack of information is viewed as a barrier preventing an otherwise assumed natural pursuit of cost effective household energy performance improvement (Jaffe and Stavins, 1994; Vedung and van der Doelen, 1998; Schleich, 2004). According to the OECD/IEA (2010, p. 11) "The theory is simple: barriers can be overcome with the design and implementation of targeted energy efficiency policies".

An array of tool comes under the information banner. As well as energy audits mass media campaigns, promotional pamphlets, interactive web based tools, workshops, smart meters and informative billing are common examples. A number of efforts have been made to categorise information tools. Hood (1983) discusses information instruments as 'general', 'group targeted' and 'custom- made'. Others categorise information as antecedent (goal setting, information etc.) and consequence (feedback)

5 Housing tenure in the Netherlands is approximately 60% owner occupied, 10% private rental and 30% social rental.

(Abrahamse et al., 2005). Further categorisations focus on the role of the energy end user with the division of 'opportunistic advice' (provided when new equipment is installed or householders move dwelling) and 'client-led advice', when householders request the information (New Perspectives, 2002).

Energy audits belong to the 'custom made' and 'antecedent' categories and they can be either 'opportunistic' or 'client-led'. In the information tools family, it is custom-made audits that are viewed as holding the most potential in stimulating the installation of energy efficiency measures (Gates, 1983; Stern, 1992; New Perspectives, 2002; Benders et al., 2006). "Social psychologists and marketing professionals know that information is more likely to change behaviour when it is specific, vivid and personalised" (cited in Stern, 1992, p. 1227).

The specificity and comprehensiveness of energy audits are illustrated in definitions and descriptions. The European Energy Service Directive defines an energy audit as: "a systematic procedure to obtain adequate knowledge of the existing energy consumption profile of a building or group of buildings, identify and quantify cost-effective energy savings opportunities, and report the findings" (EC 2006b: L114/68). National or international standards are typically followed during the audit process (Novikova et al., 2011). Breukers et al. (2009, p.82) and Novikova et al. (2011) emphasise the face-to-face contact associated with an energy audit as a distinguishing feature. This face-to-face element makes audits more engaging than tools such as the Energy Performance Certificate (EPC) required under European legislation when buildings are constructed, sold or rented but without the involvement of the 'would-be' occupant.

To summarise, the theoretical assumption is that an energy audit can remove the information deficit and unnecessary information overload by providing bespoke advice on the extant efficiency of the dwelling, recommended energy efficiency measures and expected savings in energy use and energy bills. Once armed with this information it is assumed that householders are more likely to install the energy efficiency measures recommended to them, all the more so if they have requested the audit. This brings benefits to the household and reduces the environmental impact by contributing to, inter alia, climate change policy objectives. The aim of research presented here is to furnish this assumption with empirical evidence from the Netherlands.

§ 4.2.2 Instrument implementation

As well as theories about barriers two commonly accepted theories in this domain are that a mix of instruments should be implemented and that instruments should be performance based. A mix of policy instruments is required to target multiple

barriers and market transformation opportunities (Gunningham and Sinclair, 1999; Ürge-Vorsatz et al., 2007). Meanwhile, a performance based approach is required to encourage deep retrofit instead of the installation of one-off measures (Fairey and Goldstein, 2006). As well as the preferred approach in terms of cost effectiveness it is argued that deep retrofit is required if existing dwellings are to deliver on climate change targets.

§ 4.3 Previous research

§ 4.3.1 Effects of audits

Several research projects refute the assumption that tailored advice overcomes the information deficit and stimulates investment in energy efficiency measures. McDougall et al. (1983) "in their evaluation of the Canadian EnerŞave programme" found no difference between households who had received custom made advice compared to households who had not two years after the advice was provided (cited in Abrahamse et al., 2005). Hirst and Goeltz (1985,p 26) "in their analysis of participants and non-participants of a US energy company audit programme" found only a slight influence of the audit on retrofit activity. Likewise, Frondel and Vance (2012) noted that far less than half of households who participated in an audit reported it as a decisive factor in their investment decision.

Studies into the effect of energy audits in the commercial sector show similar results with one US study finding that only half of the recommended measures from audits were taken even with relatively short (<2 years) average payback periods (cited in Breukers et al., 2009). Schleich (2004) found that energy audits reduced the information deficit but did not necessarily lead to an increase in adoption of energy efficiency measures for small and medium size enterprises in Germany.

However, not all research finds this low to absent impact of energy audits. Hirst et al. (1981) identified positive results on the cause and effect relationship of audits in the US. A study into the energy efficiency measures adopted by recipients of energy audits from six different energy companies showed that, on average, 40–50% of recipients invested in energy efficiency measures. The energy saving investments of non-recipients were only analysed by two energy companies and results showed weak impact of the energy audits. However, when comparing the investments of the energy

company audit recipients to a larger survey of 4081 non-recipients (considered more representative of the general population) the impact of energy audits were considered stronger. While, 40–50% of recipients of audits invested in energy efficiency measures, only one-third of the 4081 non-recipients had installed energy efficiency measures. Unfortunately, results of any statistical analysis associated with this study were not reported.

The Energy Efficiency Partnership for Homes also identified a positive relation between audits and investment in energy efficiency measures. Instead of comparing audit recipients to non- recipients they focused on differences between client-led advice and opportunistic advice. Their results, based on 1900 interviews of households in 2001 in the UK, showed that 70% of households with client-led advice installed some advised measures while the equivalent percentage for opportunistic advice was 63% (New Perspectives, 2002).

Few researchers have focused on why audits might not have the effect intended. Exceptions include Frondel and Vance (2012) who elaborated on a theory from Metcalf and Hassett (1999) (cited in Frondel and Vance, 2012) that audits could negatively influence decisions about adopting energy efficiency measures. They postulated that while audits may encourage some householders to invest in energy efficiency measures they could have the opposite effect on others. This opposite effect would emerge if householders become discouraged to invest if, for example, pay-back is perceived as too long. Such occurrences would result in non-significant average effects. The National Energy Foundation (2009) found another explanation following their research into why householders in receipt of EPCs in the UK do not follow recommendations to invest in energy efficiency measures. The main reason for not acting on recommendations, given by 34% of their 302 respondents, was that they disagreed with them.

Further explanations about why research on audits produces such mixed results are linked to research methodologies and the nature of bottom up research. Abrahamse et al. (2005) found that small sample sizes, especially pertinent given the large variances associated with household energy use, could explain why many studies fail to find statistical significant effects between households using policy instruments compared to those who do not. Meanwhile, Hirst et al. (1981) noted that non-participants who respond to surveys on energy efficiency measures are likely to be more interested in energy saving than the general population of non-participants, therefore skewing results. Another study showed that caution should be adopted when assuming that householders who do not participate in audit programmes are un-informed or uninterested in energy saving. This study found that non-participants could often be better labelled as 'early participants' or 'early adopters' as they were found to have taken out more energy efficiency measures before an audit programme than participants (Hartman, 1986).

§ 4.3.2 Audit recipients

While findings about the effect of energy audits are certainly mixed, agreement exists about the characteristics of householders who participate in audit programmes. Stern et al. (1986), Hirst et al. (1981) and Wirtshafter (1985) found that audit programmes consistently attracted higher income and higher educated households. "People who participate in home energy audit programs were clearly not a cross section of the general public. Utility surveys of the characteristics of programme participants always showed that they had higher educational and income levels than were average for respective locations. Another typical characteristic of participants was a greater interest/awareness/concern with energy conservation than was found among the general population" (Hirst et al., 1981, p. 628). Likewise, Bruel and Hoekstra (2005), in their research in the Netherlands, found that higher income households respond to personalised advice and appeals to improved comfort and societal responsibility while lower income households respond to subsidies and advice on reducing energy bills.

However, other research emphasises that socio-economic and demographic factors are significant variables for energy efficiency renovation in general, not only for audit recipients. Stieß et al. (2010) found that most energy based renovation activity in Germany is carried out by older households (over 50 years) with higher education and income than the average. Barr et al. (2005), Martinsson et al. (2011) and Dillman et al. (1983) found that age, housing type and income were strongly linked to more sustainable use of energy.

§ 4.4 Method

§ 4.4.1 Questionnaire and response

To investigate the role and influence of national policy instruments on the adoption of energy efficiency measures by Dutch private households an extensive online questionnaire was launched in March 2012. The questionnaire consisted of multiple choice and open ended questions divided into several categories; the adoption and planned adoption of energy efficiency measures, energy audits, the EPC, building regulations, the energy tax, financial incentives, information tools and socio-economic and dwelling characteristics.

The results presented and discussed here focus on the influence of the energy audit. An official audit (maatwerkadvies) was introduced in the Netherlands in 2000. The audit must follow national standards (BRL beoordelingsrichtlijn 9500) and includes a comprehensive energy report on energy use and possible savings. An EPC, the issue of which is required by the European Energy Performance of Buildings Directive (recast 2010) when buildings in the European Union are constructed, sold and rented is commonplace in audits. The EPC includes a building rating based on A–G with A as the most energy efficient.

Required survey sample sizes were calculated on the basis of assumptions and several critical components of the questionnaire which required a set response rate to allow statistical analysis. Slightly less than 30,000 letters (with a link to the questionnaire) were sent to households registered as having an EPC because they bought a dwelling or received an energy audit.

To create the sample for comparison over 16,000 members of the Association of Home Owners were emailed a link to the questionnaire. The Association of Home Owners represents the interests of 17.5% of Dutch homeowners (VEH, 2012). It is assumed that members of this association may be more 'engaged' than the general population of homeowners. However, other objectives of the survey meant that the comparison sample had to have purchased their dwelling in the recent past[6]. Accessing data of recent and representative dwelling purchasers was heavily restricted. Associations managing real estate data and mortgage data would not permit the use of contact details due to privacy issues. The National Land Registry would issue only a limited number of addresses, which would not have allowed for statistical analysis.

Following a reminder, a response rate of 17% was received for the EPC database and 10% for the Association of Home Owners. Following the removal of inconsistent cases and division of respondents into different groups for analysis the final count for households with an energy audit was 3737. The final count for households without an energy audit was 1779.

6 Recent dwelling purchasers were required for the survey to compare energy saving action to the EPC sample who purchased their dwelling in 2010.

§ 4.4.2 Analysis

Firstly, the 'self-reported' influence of energy audits by recipients was analysed and the association between recommendations made in the energy audit and energy efficiency measures adopted and planned was investigated using descriptive statistics.

Secondly, the dwelling and household characteristics of energy audit recipients and non-recipients were analysed to highlight any differences. Pearson's chi-square tests were conducted using SPSS v19 to identify these differences. Following Field (2009) contingency tables were created for each variable, entered into SPSS and analysed using the cross-tabulations function.

Thirdly, differences in installation and investment in energy efficiency measures between the two groups were analysed again using Pearson's chi square tests. Whether a statistical difference existed between having an energy audit and installing and planning to install energy saving measures, the quantity and type of measures installed and the amount invested was analysed.

§ 4.5 Results

The final count for recipients of an energy audit was 3737. The final count for non-recipients was 1779. However, audit recipients who were required to get an audit for a subsidy were removed. This is because the energy audit was assumed to play a weaker role in their decision making. This reduced the audit recipient count to 2232. Furthermore, 431 respondents stated that they had received the audit opportunistically, for free from the local authority or energy company. Analysis was re-run with these respondents removed as it was assumed that the audit may have been less significant for this group. Results of this analysis are reported in Section 4.5.3.6.

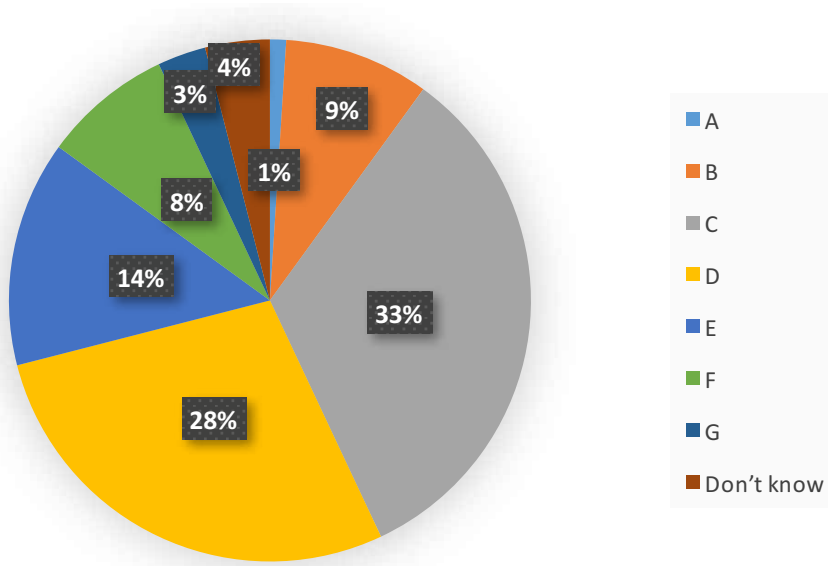

FIGURE 4.1 Energy ratings according to the energy audit

§ 4.5.1 Reported influence of energy audit

A series of questions were included in the questionnaire to seek information on the:

- Context of recipients having audits
- Energy efficiency of their dwellings
- Influence of the audit in terms of whether it led householders to go further than planned with energy efficiency measures
- Relationship between recommendations made in the audit and measures that were adopted and/or planned.

62% (1385) of audit recipients reported to have had an energy audit carried out because they wanted to know more about the energy performance of their dwelling. 26.5% (591) got an audit based on advice that they received from a third party. 31% (701) gave other reasons for having an audit, of which 59% (413) received the audit opportunistically, for free from their local authority or energy supplier. Over half of the respondents received some form of subsidy for the audit.

90% of the audit sample lived in dwellings rated C and below, see Fig. 4.1. Dutch climate change policy includes the ambition of reaching an average B rating for existing dwellings, therefore the majority of dwellings would be considered appropriate for energy performance improvement.

19% (421) respondents stated that either the audit rating or audit recommendations influenced them in their decision to install energy efficiency measures. These respondents were asked how the audit influenced them with questions presented as: Did the audit confirm information that the householder already had? Did the audit influence the householder to install more energy saving measures than planned? Did the audit influence the householder to install measures that they had not thought about previously? Multiple responses were possible. The main influence was that the audit confirmed the householder's ideas about some energy efficiency measures (n=391). This was followed by the audit influencing them to install more measures than they had planned (n=153) and influencing them to install some measures that they had not thought of previously (n=126).

MEASURE	RECOMMENDED	ADOPTED	PLANNED	% ADOPT/ PLAN COMPARED TO RECOM-MENDED	ADOPTED (NOT RECOM-MENDED)	PLANNED (NOT RECOM MENDED)
Boiler replacement	570	265	42	54	300	56
High performance glazing	1227	357	109	38	111	21
Roof insulation	875	183	103	33	96	17
Floor insulation	1089	235	123	33	73	24
Wall insulation	1048	335	80	40	92	23
Heat recovery shower	29	1	2	10	3	19
Heat recovery m. ventilation	31	5	0	16	2	8
Insulation of piping	191	48	8	29	111	19
Draught proofing	373	109	30	37	170	30
Renewable technology	668	87	118	31	60	131
Don't remember	158	-	-			
None	74	-	-			

TABLE 4.1 Measures reported as recommended, adopted and planned by audit recipients

Respondents were asked what recommended measures were listed in their energy audits and which of these they adopted and planned. Results are presented in Table 4.1. This shows that a significant portion of recommendations issued were neither adopted nor planned. Furthermore, results show a significant portion of measures were adopted or planned but not recommended.

§ 4.5.2 Sample characteristics

Table 4.2 displays the type and age of the dwelling for the two sample groups. A significant difference between the two sample groups was identified in the dwelling type category, χ^2 (5) = 144.83, p < .001. Audit recipients were more dwellings likely to live in detached dwellings and less likely to live in apartment dwellings with values for standardised residuals significant at <.01 and <.001 respectively

A significant difference was also identified between the two sample groups for the dwelling age category, χ^2 (5) = 231.56, p < .001. 96.5% of audit recipients lived in pre-1990 dwellings and 84% of non-recipients. Audit recipients were more likely to live in the 1971–1990 category. Furthermore, audit recipients are under-represented in the post 1991 category compared to non- recipients.

DWELLING CHARACTERISTICS	AUDIT RECIPIENTS		AUDIT NON-RECIPIENTS		STANDARDISED RESIDUALS *	P***
	#	%	#	%		
Type						
Apartment	28	1	151	9	<.001	.000
Detached	600	29	351	22	<.01	
2 under 1 roof	504	24	331	21	**	
Corner	345	16	261	16	**	
Terraced	554	26	455	28	**	
Other	67	3	56	3.5	**	
Age						
Pre 1945	589	28	488	30	**	.000
1945-1970	510	24	331	21	**	
1971-1990	927	44	523	33	<.001	
1991-2000	67	3	158	10	<.001	
2001-	2	<1%	102	6	<.001	
Don't know	3	<1%	3	<1%	**	

*+Missing cases are respondents who did not complete the entire survey; * Based on chi-square test; **No statistical difference; ***Using Monte Carlo method*

TABLE 4.2 Dwelling characteristics (including missing cases)+

Compared to the national average[7] apartment dwellers were under-represented for both groups and householders in detached dwellings over-represented (national averages taken from Eurostat, 2009). Compared to the national average, older dwellings were over-represented among the audit recipient group with the non-recipient group being more representative, 28% of the audit sample lived in pre 1945 dwellings with the national average at approximately 21% (national averages taken from Itard and Meijer, 2008).

Table 4.3 shows household characteristics for audit recipients and non-recipients. With the exception of 'income', χ^2 (5) = 14.30, p >.05 there were significant differences in all categories. Most differences between the two samples appear to stem from different life stages between the two groups.

7 According to Eurostat (2009) 16% of the national population lives in apartments but this figure includes social housing (30% of total housing in the Nether- lands). Meanwhile, 17.6% of the national population live in detached dwellings.

HOUSEHOLD CHARACTERISTICS	AUDIT NON-RECIPIENTS		AUDIT NON-RECIPIENTS		STANDARDISED RESIDUALS *	P***
	#	%	#	%		
Size						
1 person	263	13	249	15.5	**	.000
2	1127	54	727	45	<.001	
3	241	11.5	258	16	<.001	
4	347	17	244	15	**	
4>	114	5	125	8	<.001	
Age						
20-39	193	9	464	26	<.001	.000
40-65	1120	50	842	47	**	
66-79	606	27	190	11	<.001	
80>	40	2	18	1	**	
Not stated	273	12	270	15	**	
Education						
School	8	<1	6	<1	**	0.001
High School	134	6	84	5	**	
Lower vocational	49	2	22	1	**	
Middle vocational	401	19	265	17	**	
Higher vocational	892	43	660	41.5	**	
University	572	27	535	34	<.001	
Other	38	2	18	1	**	
Employment						
Part-time	340	16	314	20	**	.000
Full-time	744	36	879	56	<.001	
Unemployed	52	2.5	31	2	**	
Retired	802	39	261	16.5	<.001	
Student	0	0	8	<1%	**	
Other	133	6	85	5	**	
-Monthly net income						
<1,000	17	<1%	7	<1	**	0.13
1,000-1,350	44	2	44	3	**	
1,350-1,800	155	7	116	7	**	
1,800-3,150	816	39	548	35	**	
3,150>	692	33	540	34	**	
Not stated	360	17	327	20	**	
Duration of occupation						
<1 year	3	<1	92	6	<.001	.000
1-5 years	285	13	968	61	<.001	
5>	1784	80	530	33	<.001	

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HOUSEHOLD CHARACTERISTICS	AUDIT NON-RECIPIENTS		AUDIT NON-RECIPIENTS		STANDARDISED RESIDUALS *	P***
	#	%	#	%		
Plans to move						
Within 1 year	54	2	40	2.5	**	.028
1-5 years	183	8	144	9	**	
>5 years	384	17	235	15	<.05	
None	1463	65,5	1177	74	**	

*+Missing cases are respondents who did not complete the entire survey; * Based on chi-square test; **No statistical difference; ***Using Monte Carlo method.*

TABLE 4.3 Household characteristics (including missing cases+)

Age appeared as a significant factor in having an energy audit χ^2 (4) =331.08, p<.001. Recipients of audits were more likely to be older with a highly significant difference in the over 66 age category and 20–39 category compared to the non-recipients. Significant differences were found for employment status, χ^2 (5)=249.43, p<.001 and education, χ^2 (6)=24.36, p<.01 with audit recipients more likely to be retired and less likely to have a university education compared to non-recipients which also presumably relates to generational differences.

Household size was found to be significant, χ^2 (4) = 41.73, p<.001 with audit recipients more likely to live in two person households. Significant differences were also found for length of occupation, χ^2 (2) = 1090.68, p < .001 and plans to move, χ^2 (3) = 9.03, p < .05. In these cases, audit recipients were more likely to have lived in their dwellings for longer than five years and non- recipients were less likely to plan to move dwelling within five years.

Compared to the national average the two samples were more highly educated with higher incomes (based on national averages from CBS, 2010). However, the samples could be considered more representative of the private owner-occupied sector where incomes are higher than the national average (based on national averages VROM and CBS, 2009). In terms of age the non-recipient group could be considered more representative than the recipient group with an average age of 49 and 58 respectively compared to a national average of 41[8] (based on national averages CIA, 2012).

8 Total population including non-home owners.

§ 4.5.3 Energy efficiency measures and the energy audit

In this section results of statistical analysis into the differences in installation, investment and plans for the installation of energy efficiency measures between the audit recipient group and the non-recipient group are presented. Results are displayed in Table 4.4 and further elaborated in the sections below.

§ 4.5.3.1 Adoption of energy efficiency measures

64% (1370) of the audit sample stated that they had adopted energy efficiency measures since receiving the energy audit. 63% (1091) of the non-recipient group had adopted energy efficiency measures since buying their dwelling. There was no significant association between having an audit and carrying out energy efficiency measures, $\chi^2(1)=.280$, $p>.05$

§ 4.5.3.2 Quantity of energy efficiency measures adopted

When examining the quantity of energy efficiency measures adopted by the two groups a significant difference was identified, $\chi^2(6)=100.94$, $p<.001$. This test initially had to be limited to seven measures because of low sample size for those respondents who adopted eight and nine measures. Standardised residuals for the adoption of one and two measures are significant with audit recipients more likely to install this quantity of measures. This bottoms out at the adoption of three measures which does not show significance for either group. However, from the adoption of four measures upwards the standardised residuals are again significant but reversed with non-recipients more likely to adopt four or more measures. This peaks at the adoption of five measures which shows a highly significant relationship with residuals of 4.0 and -3.6 for non-recipients and recipients respectively ($p<.001$). To explore these results further measures are clustered into two groups: one and two measures, and four to nine measures.[9]

Grouping the measures into one and two measures and four to nine measures confirmed significant differences between the two samples, $\chi^2(1) = 94.93$, $p<.001$. Audit recipients were significantly more likely to have installed one and two energy

9 Adoption of eight and nine measures are now included as together counts are large enough for the chi-square test

efficiency measures and non-recipients significantly less likely with standardised residuals of 2.9 and -3.2 respectively ($p < .01$). When measures are increased to four to nine there is a reversal with standardised residuals of 6.5 and -5.8 highly significant at $p < .001$ showing that non-recipients installed more measures and recipients less than expected.

VARIABLE	AUDIT RECIPIENTS N=2148		AUDIT NON-RECIPIENTS N=1733		STANDARDISED RESIDUALS	P
	#	%	#	%		
Adoption of energy efficiency measure(s)	1370	64	1091	63	**	.615
Number of energy efficiency measures adopted*						
One	564	42.5	353	33	<.01	.000 ***
Two	434	33	274	26	<.05	
Three	190	14	177	17	**	
Four	85	6	122	11	<.01	
Five	32	2	75	7	<.001	
Six	14	1	36	3	<.01	
Seven	4	1	20	2	<.01	
Eight	0	0	5	<1%	--	
Nine	0	0	1	<1%	--	
Number of energy efficiency measures grouped						
One-two	998	88	627	71	<.01	.000
Four-nine	135	12	259	29	<.001	
Investment in energy efficiency measures						
>€4,000	400	29	379	36	<.01	.000
€2,000-€4,000	393	29	284	27	**	
€1,000-€2,000	357	26	227	21	**	
€500-€1,000	117	9	83	8	**	
<€500	96	7	93	9	**	
Planned adoption of measure(s)						
	n=2130		n=1680			
	600	28	586	35	<.01	.000
Estimated investment in planned measures						
>€4,000	167	28	173	30	**	.209
€2,000-€4,000	200	33	158	27	**	
€1,000-€2,000	134	22	141	24	**	
€500-€1,000	67	11	74	13	**	
<€500	31	5	37	6	**	

**Excluding 'other answers'; **Not significant; ***Using Pearson's chi-square test with Monte Carlo Method.*

TABLE 4.4 Differences in adoption, investment and plans to adopt and invest in energy saving measures

§ 4.5.3.3 Types of energy efficiency measures adopted

Table 4.5 displays frequencies, percentages, χ^2 values and p values relating to the types of energy efficiency measures installed by recipients and non-recipients. Significant differences are noted in the adoption of all measures except for floor insulation and heat recovery from showers The reason(s) for these differences were not known..

Non-recipients were more likely to install the following measures: boiler replacement, high performance glazing, roof insulation, heat recovery from ventilation, piping insulation, draught proofing and 'other'[10] measures. Meanwhile, audit recipients were more likely to install wall insulation and renewable technology compared to non recipients.

MEASURE	AUDIT RECIPIENTS N=1367			AUDIT NON-RECIPIENTS N=1087				
	# ADOPTED	# NOT ADOPTED	% ADOPTED	# ADOPTED	# NOT ADOPTED	% ADOPTED	X2 (1)	P
Boiler replacement	568	799	41.5	634	453	58	68.18	.000
High performance glazing	468	899	34	443	644	41	11.02	.001
Roof insulation	285	1082	21	333	754	31	30.78	.000
Floor insulation	311	1056	23	269	818	25	1.65	.251
Wall insulation	431	936	31.5	228	859	21	35.1	.000
Heat recovery shower	4	1363	<1	9	1078	<1	3.29	.092
Heat recovery m. ventilation	7	1360	<1	15	1072	1	5.13	.030
Insulation of piping	159	1208	12	281	806	26	83.2	.000
Draught proofing	279	1088	20	413	678	38	90.71	.000
Renewable tech-nology	152	1215	11	88	999	8	7.83	.014
Other	111	1214	8	124	937	11	7.27	.007

TABLE 4.5 Differences in types of measures adopted by recipients and non-recipient

10 In the 'other' measures category respondents were free to enter their own comments. Respondents varied in their answers but frequently listed lower level measures such as radiator foil or energy efficient appliance purchases as well as altering habitual behavioural such as reducing number of showers.

§ 4.5.3.4 Amount (€) invested in energy efficiency measures

A significant difference was identified in the amount invested in energy saving measures between the two samples with standardised residuals showing that this significance stems from non-recipients who were more likely to spend over €4000.

§ 4.5.3.5 Future plans for energy efficiency measures

Similarly, non-recipients were more likely to plan on taking energy saving measures $\chi^2(2)1=26.62$, $p<.001$. There was no significant difference between the two groups in terms of the amount planned for future investment, $\chi^2(4)=5.87$, $p>.05$.

§ 4.5.3.6 Opportunistic recipients removed

413 respondents from the audit sample stated that they had received the audit opportunistically, for example, through pilot projects offered by their municipality or from their energy provider. These cases were removed and the remaining sample was compared to the original audit sample for all the analysis categories: differences in whether energy efficiency measures were installed, the quantity and type of measures adopted, amount invested in measures, planned installation and investment in measures. There were no statistical differences identified in any of the categories.

§ 4.6 Discussion and recommendations

§ 4.6.1 The role and influence of energy audits

Results presented here agree with other research findings (Hirst and Goeltz, 1985; Abrahamse et al., 2005; Frondel and Vance, 2012) that show the energy audit as a weak variable in the overall decision to invest in household energy efficiency measures. Only 19% (421) of audit recipients who adopted energy efficiency measures stated that the audit rating or recommendations influenced their decision. The weak influence of the audit is further confirmed in the wide disparity between the measures that were

recommended in the audit and the number and types of measures that were adopted and planned see Table 4.1. Even in the unlikely scenario that all the planned measures are actually adopted it remains that between 60% and 70% of recommendations were ignored. This percentage is even greater for innovative measures like heat recovery measures. Moreover, Table 4.1 shows that some measures were adopted or planned which were not recommended, further questioning the role of the audit in householder decision making. The installation of renewable technology appears the most popular 'planned but not recommended measure'. This could be regarded as one of the least cost effective measures among the typical list of audit recommendations. This shows the competing influences of non-economic and technical variables such as motives and goals in the investment decisions of householders as highlighted authors like Zundel and Stieß (2011). This also casts into doubt popular models like the barrier model based on an understanding of householders as rational economic agents and highlights the complexity of decision making in this area.

Another dimension to exploring the role and influence of the audit was to compare audit recipients to non-recipients. As with the research findings identified by Hirst and Goeltz (1985), Abrahamse et al. (2005) and Frondel and Vance (2012) audit recipients were not more likely to adopt energy efficiency measures compared to non-recipients[11]. In fact, results presented here show that non-recipients were likely to invest more in measures and plan more measures than recipients. Moreover, while the norm among both samples was the adoption of one or two measures, non-recipients were likely to invest in a greater number of measures than audit recipients.

However, as with much research in this area difficulties with representativeness were encountered. Audit recipients were older, lived in their dwellings for longer, lived in older dwellings and were more likely to be retired. Non-recipients meanwhile moved into their dwellings more recently and on this basis may have been more likely to have carried out some key energy efficiency measures in the recent past. Although, this fact could be offset by the fact that non-recipients were more likely to live in newer dwellings; especially post 1990 when performance based building energy standards were introduced into Dutch legislation. Nonetheless, it is assumed that non-recipients who responded to the questionnaire may have been more interested and likely to have carried out energy efficiency measures than the general population and be at a stage in their dwelling occupation where they are more likely to be adopting and planning energy efficiency measures.

11 There was no significant association found for having an audit and carrying out energy saving measures. Results of research presented in chapter 3 did not find this which is explained by sample differences. The sample in this chapter did not contain respondents who had an audit because it was required to receive a subsidy while the sample in chapter 3 did.

While respondents from the two sample groups showed some divergence in key aspects, respondents, in general, are not representative of the national population. Research findings presented here agree with other conclusions that survey respondents/audit participants have higher income and education levels than the national average (Hirst et al., 1981; Wirtshafter, 1985; Stern et al., 1986; Stieß, et al., 2010). However, when compared only to the private owner occupied sector, respondents might be more representative.

Results presented here highlight interesting dimensions of the barrier model on which instruments are based. One finding is that many barriers are unaccounted for in the policy instrument package used to tackle existing dwellings. This is manifested in the top five reasons for not adopting or planning energy efficiency measures among the audit sample (n=776):

- a) dwellings are considered to be adequately energy efficient- 36% (278)
- b) lack of finances-29% (228)
- c) uncertainty about length of residence at particular dwelling-24% (184)
- d) payback considered too long-18% (143)
- e) measures considered to be too much hassle-14% (106)

Financial (b & d) and 'hassle' (e) related barriers are typically reflected in policy instruments developed for existing dwellings. However, consideration that dwellings are adequately energy efficient (a) and uncertainty about length of residence (c) are not dealt with by the policy instrument arsenal for existing dwellings. Fig. 4.1 shows that 10% of respondents lived in dwellings that are rated A or B which are outside the main thrust of policy attention in the Netherlands. This is significantly less than the 36% who considered their dwellings to be energy efficient. Moreover, almost a quarter of households cited uncertainty about the length of time they will occupy their dwelling as a reason for not investing in measures. In these cases, householders considered that their investment is unlikely to be returned in a future property sale.

Another finding in terms of the barrier model is that removing the information deficit barrier did not lead to a positive outcome in terms of investment in energy efficiency measures among many respondents. Interestingly many respondents who cited payback time as a barrier to investment mentioned that the auditor advised them that measures were not cost effective. Just as audits can confirm ideas about what measures to take it seems likely that they can create adverse feelings about installing measures, particularly if there is a negative emphasis on economic aspects. This links to the findings of other researchers that audits can influence householders not to invest in measures (see Frondel and Vance, 2012).

§ 4.6.2 Recommendations

Results of research presented here show weaknesses of an approach based on addressing a limited number of barriers and on the purely voluntary participation of householders in the energy performance improvement of the existing stock. The main reason for not investing in energy efficiency measures among both sample groups was consideration that dwellings were already energy efficient enough. This is despite over 70% of recommendations being ignored among the audit sample. Moreover, other reasons cited by householders for not investing in energy efficiency measures, for example, uncertainty about length of occupation, are not dealt with by current instruments.

Based on the above it is argued that instruments based on 'take it or leave it' recommendations have to be second place to instruments with a clear signal of what represents an energy efficient dwelling. A possible solution is a minimum standard for existing dwellings or different categories of existing dwellings. Such a standard could be enforced at 'natural' moments such as at the point of sale or renovation. A minimum standard could also offer householders a clearer benchmark when they do carry out energy efficiency measures encouraging them to go beyond their own perception of comfort and acceptable energy bill expenditures. Furthermore, a minimum standard would integrate energy efficiency into property valuations guaranteeing householders who might otherwise not be inclined to install energy efficiency measures because of uncertainty surrounding length of occupation that they will get a return on their investment during a future sale. However, a minimum standard for existing dwellings has possible negative effects not least on householders already living in fuel poverty in inefficient dwellings. Further research is required to fully explore the role and effect of a minimum standard.

A further recommendation stems from the fact that among both sample groups the installation of one or two energy efficiency measures was the norm. This illustrates the need for information instruments that support deep retrofit and incentivising performance based financial instruments. Financial barriers, either through a lack of finances or dissatisfaction with the payback period, are longstanding for energy performance improvement in the existing housing stock. More innovative financial mechanisms such as the performance based approach to deep retrofit promoted by KfW loans in Germany or loans attached to properties and repaid through savings in energy bills as proposed by the Green Deal in the UK could reduce financial barriers while concomitantly promoting deeper retrofit.

Lastly, more research is called for to gain a fuller understanding of (1) whether instruments perform as intended (2) the way different policy instruments interact with one another and (3) how deep retrofit and a performance based approach can be supported in instrument design. As policy interventions can play a key role in altering the business as usual approach to household investment in energy efficiency measures it is crucial that their influence is comprehensively understood.

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5 The influence of the Energy Performance Certificate: The Dutch case

Abstract

All European Union Member States require an Energy Performance Certificate (EPC) when buildings are constructed, sold and rented. At its introduction the EPC was considered a pioneering instrument, one that would help overcome an information deficit hindering consumer interest in energy efficient dwellings. Now that the EPC has been implemented for several years it is possible to examine its impact. This research draws on data from ex-ante and ex-post assessments of the EPC in a number of countries and presents the results of a survey of Dutch private dwelling purchasers. This survey was based on two sample populations, one received an EPC during property transaction and another did not. Differences were sought between the two samples in a number of areas relating to the adoption of energy efficiency measures. Results show that many projections about the impact of the EPC have fallen short. The EPC was found to have a weak influence, especially pre-purchase. The potential of the EPC in driving energy efficiency improvement in the existing stock is doubted especially if it continues to act independent from a mix of instruments designed to tackle multiple barriers. It is argued that the energy saving potential of existing dwellings, applauded in climate change policy, will remain unexploited if it continues to be assessed subjectively by householders.

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§ 5.1 Introduction

The EPC was introduced as a requirement for European Union Member States by the Energy Performance of Buildings Directive 2002 (recast 2010) with most Member States requiring the EPC by 2008. The EPC assigns a building a rating based on the energy efficiency of the thermal envelope and installations. Ratings range from A to G, A being the most efficient. Alongside this, the EPC can contain recommendations

showing what energy efficiency improvements are possible and in some cases what corresponding cost savings can be expected.

At its debut the EPC was considered a pioneering instrument. The European Commission (EC) heralded it as "a powerful tool to create a demand-driven market for energy efficient buildings... allow[ing] economic agents to estimate costs in relation to energy consumption and efficiency" (EC, 2008, p. 5). The outreach capacity of the EPC formed an appeal to some commentators as: "arguably the most commonly available and accessible source of advice to home sellers and buyers about the sorts of improvements that could help save both cash and carbon" (NHER, 2009). Similarly, "the certificate provides a unique opportunity to formulate individual action proposals for each house and each property owner" (SOU, 2008, p. 66). Other statements show that the EPC was expected to play a significant role in market transformation because it "sends a powerful message to homeowners, the construction industry and appliance suppliers alike. It empowers consumers to factor in energy efficiency as part of their decision to buy a particular property and to understand better how they can have control over the energy performance of their home (by consumption patterns and home improvements). Construction and appliance suppliers will have to respond to the needs of better-informed consumers" (cited in Parnell and Popovic Larsen, 2005, p. 1093).

The bold statements of early policy responses have yet to come to fruition. Implementation issues and a lackluster response from buyers and sellers in many European Member States means that the EPC is not the empowering tool leading the charge to market transformation that was expected (Laine, 2011; Watts et al., 2011; Amecke, 2012; Backhaus et al., 2011).

The aim of research presented here is to comprehensively assess the EPC in the Netherlands. It is possible to piece together different aspects relating to how the EPC functions, pre and post purchase, from research projects in various European countries. In this research how the EPC functions across all aspects, pre and post purchase is assessed in depth for one country. Moreover, the lack of an enforcement regime for the EPC in the Netherlands at the time of research allowed for recent homeowners with an EPC to be compared to recent homeowners without an EPC, an important dimension to understanding the effectiveness of the EPC that has not been previously reported. As well as assessing the differences in terms of energy saving measures adopted and planned the reasons why homeowners did not have an EPC at the time of purchasing their property was assessed.

§ 5.2 Barriers, behaviour and instruments

The persistent failure of many households to carry out cost effective energy saving measures in their dwellings has enjoyed attention for several decades (Gates, 1983; Jaffe and Stavins, 1994; Curtain and Maguire, 2011). Research shows that households behave differently to rising energy prices and to public campaigns to reduce energy use depending on large range of variables including income, age, location, the energy saving measures being promoted, the information at their disposal and their personal norms and values (Poortinga et al., 2003; Martinsson et al., 2011). Some of the more consistent and alterable variables such as financial ability and information are linked to the 'barrier-model' of developing instruments.

The barrier model theorises that householders do not capitalise on opportunities to improve the energy efficiency of their dwellings because of well-rehearsed obstacles including but not limited to difficulties in meeting the upfront costs of energy saving measures, hassle and lack of trusted information (Blumstein et al., 1980; Shove, 1998; Weber, 1997). The EPC can be viewed as a reaction to the information deficit barrier. Its application at the property transaction point appears during an important natural moment that could aid market transformation by driving sellers to improve their property or potential buyers to negotiate on the basis of a poor EPC rating. Furthermore, it provides information on energy saving measures that could be applied post-purchase.

However, the apparent logic of the barrier model and the instruments formulated in response can clash with research applied to decipher household attitudes and behaviour at a deeper level. Collins et al. (2003, p. 25), for example, are highly critical of the way some information tools are formulated and perceived to operate: "Eco-labelling is perhaps the best example of a policy which relies on a naïve conceptualisation of human behaviour. The assumption is that information drives action-all the available evidence suggests that this is a false assumption: people do not purchase in a rational, information seeking way". The barrier model is also subject to criticism because of its simplicity. Instead of developing instruments in reaction to specific barriers Blumstein et al. (1980) and Shove (1998) have called for greater understanding of the nature, variation and interaction of barriers across time, space and different households. This sentiment is echoed in segmentation models of populations based on their resources, attitudes and propensity to act on their knowledge and beliefs. These models consistently show that householders make up such a rich tapestry that 'one size fits all' instruments will simply miss the target (Vringer et al., 2007; Egmond et al., 2006; Sutterlin et al., 2011).

A range of literary sources confirms that the conceptual pillar of many instruments – the rational, information seeking individual – is a minority. Thaler and Sunstein

(2008) call this minority Econs, whereas the majority of people are Humans, led by emotion and often the agents of poor decisions that defy economic logic. This division in how populations react also has a home in diffusion research. There are innovators and laggards and in between a great majority (Rogers, 2005). Diffusion and market transformation literature cajoles that once the great majority is reached, goals come into sight and policy efforts pay off. Gladwell (2002) calls this the tipping point. How this tipping point can be reached and the types of interventions that can lead to it are surrounded by uncertainty and complexity.

Some pointers are offered by theories from marketing, economic behaviour, psychology and diffusion in the promotion of a combined instrument approach. Stern (2000, p. 419) notes that "since different individuals face different impediments to behaviour change and the impediments are often multiple, little happens until the right combination of interventions is found". A communication instrument like the EPC is especially considered in need of companions, "communication instruments can be useful when it comes to addressing information problems, but they are generally considered to be supplementary policy instruments, not substitutes for economic or regulatory instruments" (cited in Sunikka, 2006). Stern (1999) echoed this statement finding that information alone, depending on careful design and delivery, could change certain kinds of environmentally significant consumer behaviour to a modest extent. He found that there was little to no effect of information tools when there are other barriers external to the individual such as financial barriers and inconvenience. A number of research projects on perceived and actual impact of the EPC illustrate some of the aforementioned concepts and complexities.

§ 5.3 Previous research

A clear divergence between ex-ante and ex-post research on the EPC exists. Ex-ante results show restrained positivity towards the EPC but with a repeated caveat that it must be embedded in a wider framework of instruments. Sunikka (2006) termed it a "first step towards influencing consumer preferences". Likewise, Parnell and Popovic Larsen (2005) state that it is a positive first step but that improvement would be needed to ensure effectiveness and that it would need to be embedded in a wider programme of domestic energy efficiency support. The results of a European project BELAS which involved the critical appraisal of then extant variants of the EPC in participating Member States concluded that for the EPC to be successful it must be "'pushed' by institutional users, or 'pulled' by government". They went on to say, "Energy labelling, when integrated into a well-designed overall approach and programme, can contribute to inciting energy saving investments" (BELAS, 2001).

The results of another European project IMPACT came to similar conclusions and it was put forward that recommendations in the EPC could form a basis for other policy instruments (IMPACT, 2005).

Other ex-ante assessments showed that the EPC could expect a warm welcome on the property market. In the UK, in a sample of over 2000 individuals, 78% stated that it would be important to look at the EPC rating before buying and 70% stated that they would consider re-negotiating the property price if they discovered it was highly energy inefficient (EST, 2008). The European project IDEAL EPBD found that in a survey of over 3000 European households 60% mentioned expected utility costs as important in a purchasing decision while 40% mentioned the type of heating system. When asked directly about energy efficiency results were weaker with 14% of a UK sample stating that energy efficiency would be a factor in purchasing a property (Laine, 2011). Surveys show that energy efficiency, however valued by householders, is consistently topped by the heavyweights and 'unalterables' of location, size and price.

Furthermore, ex-ante reports suggested that between 18% and 46% of households could be expected to act on recommendations in an EPC post-purchase (IMPACT, 2005). The IMPACT study showed that in a sample of householders in Germany 40% of owners and landlords stated that the EPC prompted renovation activity. In the same study, 27% of the Dutch sample stated that, on the basis of the EPC, they intended to implement measures within the year with 18% not having this intention before receiving the EPC. These samples were small, less than 100 households, so could not be generalised. Similarly, in a survey of 256 householders who received a precursor to the EPC, 46% stated that they intended to carry out at least one of the recommendations during that year (Parnell et al., 2002). Whether they were already planning on implementing a recommendation without the EPC was not analysed.

Ex-post assessments display differences between the stated and revealed preferences of householders, especially pre-purchase. While EST (2008) found in their ex-ante assessment that 70% of a sample in the UK would negotiate price on the basis of a low EPC rating, Laine (2011) found, from a survey of a similar sample size in the UK, that 18% actually used it as part of negotiation. Watts et al. (2011) also found on the basis of responses from approximately 200 households that the EPC had little impact on price negotiation in the UK. A study in Germany based on 662 respondents concluded that "the EPC is only a moderately effective information instrument for helping purchasers to incorporate energy efficiency into their purchasing decisions" (Amecke, 2012, p. 8). Amecke (2012) also concluded that energy efficiency is diminished by factors like price, location, and outdoor space. The largest ex-post European wide study of the EPC, IDEAL EPBD, came to bleak conclusion that the EPC plays a minor, if any, role in homeowners decision-making (Backhaus et al., 2011).

On the basis of qualitative interviewing Laine (2011) uncovered some explanation for the gap between the hypothetical and actual reality of buying a dwelling with a poor EPC rating. Interviewees discussed the stress of property purchase and the fear of losing out if appearing difficult. Moreover, improvement works and energy saving measures were more commonly accepted as activity carried out post-purchase (ibid). This corresponded to a finding by Gram- Hanssen et al. (2007) based on qualitative interviews with 10 Danish households which found that the EPC is not used in the decision of buying a dwelling but in what to do with it post-purchase.

A number of ex-post studies have examined the post-purchase impact of the EPC in different EU countries. The precise role of recommendations in the EPC is difficult to isolate from the background noise of other influences and variables. NHER (2009) attempted to identify the role of EPC recommendations among UK householders through a phone survey of 302 EPC recipients and analysis of over 300,000 EPCs. They found that 32% of households surveyed had implemented some energy saving measures and 9% intended to. Loft insulation was the most commonly installed measure but improvements to the heating system was the most recommended measure showing a mismatch between the most frequently recommended measure compared to the most frequently adopted measure. A study in Denmark noted that over 45% of householders with EPCs stated that they had implemented energy savings in the first year but a cause and effect relationship with the EPC was not identified (Laustsen and Lorenzen, 2003). Another Danish study based on phone interviews of 300 households with an EPC and 300 without identified a difference in investment priorities between households with an EPC and those without. In this case, households with an EPC were subject to deeper energy efficiency measures but the difference was noted as 'almost statistically insignificant' (cited in Kjaerbye, 2008). Results from the IDEAL EPBD project also identified an impact of EPCs post-purchase. Householders with EPCs with recommendations were twice as likely to have carried out energy saving measures compared to those without recommendations or unaware of their EPC (Tigchelaar et al., 2011, p. 6).

The reasons why householders act on recommendations or undertake energy saving measures frequently relate to, inter alia, comfort, desire to save money and environmental concern (Bruel and Hoekstra, 2005). The reasons for not acting range from lack of finances and time to uncertainty about the length of time householders plan to live in a particular dwelling (ibid). Two studies have pointed to an interesting finding on why householders may not follow the recommendations listed on their EPCs. Tigchelaar et al. (2011, p. 8) noted that almost 40% of Dutch householders did not trust EPC recommendations. Likewise, the NHER (2009) found that the main reason for not acting among their sample was that householders did not agree with recommendations.

Brounen and Kok (2010) examined the impact of the EPC using a different approach from the bottom up surveys of the stated and revealed preferences of householders described above. They carried out a large statistical study using the EPC database, a large real estate database and economic and voting data in the Netherlands. They found that houses with an A, B or C rating enjoyed a 2.8% price premium. In addition, they found that EPCs were more popular in less competitive housing areas of high-density and low average monthly incomes in areas of 'green' political sympathies. The authors concluded that the EPC represents a "moderately powerful market signal". While survey data shows that the EPC fails to have a direct influence during negotiation and decision making the Brounen and Kok (2010) study shows that a higher EPC plays an indirect positive role. This study is comparable to an Australian study that found a statistically significant relationship between energy efficiency as displayed in an energy rating and house price (Department of the Environment Water Heritage and the Arts, 2008).

§ 5.4 Methodology

§ 5.4.1 Context

The EPC was introduced in the Netherlands in 2008 with a revised version introduced in 2010 with the requirement that, inter alia, recommendations be included. In the Netherlands an EPC should accompany a dwelling (constructed more than ten years ago) when it is sold or rented. Initially the EPC was reasonably well accepted with two thirds of dwellings on the market complying with the requirement (Milieu Centraal, 2009). However, public acceptance plummeted in its initial year after a consumer programme showed the same dwelling obtaining several different EPC ratings. Added to this, the EPC was not introduced with an enforcement regime. Commonly, it would be stated in property advertisements that an EPC was 'unavailable' or 'not applicable'. Effects of the negative publicity and lack of enforcement became clearly manifest in 2010 when 10% of dwellings were sold with an EPC, this climbed to 16% in 2011 (CBS, 2011).

§ 5.4.2 Survey design and distribution

To comprehensively assess the role of the EPC, as well as the complete range of instruments that households in the Netherlands are exposed to, an online questionnaire consisting of 96 questions was created in 2012. The questionnaire consisted of multiple choice and open ended questions divided into several categories: the adoption and planned adoption of energy efficiency measures, the EPC, energy audit, building regulations, the energy tax, financial incentives, information tools and socio-economic and dwelling characteristics.

Required sample sizes were calculated on the basis of assumptions and several critical components of the questionnaire that required a set response rate to allow statistical comparison (See Appendix 2). Slightly less than 30,000 questionnaires were sent to households in the EPC database. The EPC database contains households with an EPC because they bought a dwelling, rented a dwelling or because they had an energy audit carried out (an EPC is included in official energy audits). It was assumed that the majority of registrations would have an EPC because they received an energy audit. Therefore, a large sample size was required to capture householders with an EPC because of the property transaction process.

To create the comparison sample over 16,000 members of the Association of Home Owners, who recently purchased their dwelling, were sent an email with a link to the questionnaire. The Association of Home Owners represents the interests of 17.5% of Dutch homeowners (VEH, 2012). As this is a fee-paying members based organisation it is assumed that they are not entirely representative of the Dutch population. However, accessing data of recent and representative dwelling purchasers was restricted. Associations managing real estate data and mortgage data would not permit the use of contact details due to privacy issues. The National Land Registry would issue only a limited number of addresses, which would not have allowed for statistical analysis.

Following a reminder, a response rate of 17% was received for the EPC database and 10% for the Association of Home Owners. After splitting respondents into various groups for further analysis and removing inconsistent cases, the final count for sample populations discussed here is 297 for recent dwelling purchasers with an EPC and 1027 for those without.

§ 5.4.3 Analysis

Firstly, some key characteristics of the sample groups, considered as influential factors in the adoption of energy efficiency measures were analysed. Characteristics are divided into dwelling related (dwelling type and age) and household related (size, age, education, employment, income, duration of occupation and plans to move dwelling). As variables are categorical and the aim was to determine differences Pearson's chi-squared tests were conducted following the procedures described by Field (2009).

A second stage of analysis involved examining the influence of the EPC and contextual aspects of investment behaviour as reported by recipients. Why respondents came to possess an EPC or not and the influence of the EPC pre and post-sale are described in this section. Furthermore, the reasons why EPC recipients and non-recipients adopted and did not adopt efficiency measures and the funding mechanisms used are described. This analysis stage is limited to descriptive statistics.

The last stage of analysis involved examining differences in the adoption and planned adoption of energy efficiency measures between EPC recipients and non-recipients. Pearson's chi-squared tests were conducted to test for association between having, and not having, an EPC and:

- Actual adoption of measures
- Number of measures adopted
- Type of measures adopted
- Amount invested in measures
- Planned adoption of measures
- Planned investment.

§ 5.5 Results

§ 5.5.1 Sample characteristics

No statistical significance was found for having an EPC and living in a certain dwelling categoryχ^2 (5)= 9.5, p > .05 (see Table 5.1). However, a statistical significance was noted in the dwelling age category with EPC recipients more likely to live in older dwellings χ^2 (4) = 39.53, p < .001.

In terms of household characteristics there was no statistical significance between having an EPC and household size, χ^2 (4)= 7.97, p > .05 or plans to move, χ^2 (3) = 4.08, p > .05 (Table 5.2). However, statistical significance was found for education, employment, age, income and duration of occupation (Table 5.2). In terms of education non-recipients were more likely to have a mid-level vocational training than non-recipients and less likely to have a university education, χ^2 (6) = 20.51, p < .01.

DWELLING CHARACTERISTICS	EPC RECIPIENTS		EPC NON-RECIPIENTS		STANDARDISED RESIDUALS*	P
	#	%	#	%		
Type						
Apartment	19	7	117	13	<.05	.099
Detached	56	21	161	17	**	
2 under 1 roof	42	15	171	19	**	
Corner	52	19	158	17	**	
Terraced	94	35	288	31	**	
Other	8	3	25	3	**	
Age						
Pre 1945	66	24	301	33	**	.000
1945-1970	82	30	189	20.5	<.01	
1971-1990	101	37	247	27	<.05	
1991-2000	17	6	105	11	<.05	
2001-	5	2	77	8	<.05	
Don't know	0	0	1	<1		

TABLE 5.1 Dwelling characteristics (including missing cases)
*+Missing cases=respondents who did not complete the survey; *Based on chi-squared tests; **No statistical difference+*

In terms of employment EPC recipients were more likely to be retired, χ^2 (5) = 19.35, p < .01 and to belong to the 66–79 age category, χ^2 (4) = 39.53, p < .05. EPC recipients had a higher than expected count in the €1350–€1800 monthly income bracket resulting in statistical significance, χ^2 (5) = 13.68, p < .05. Meanwhile, EPC recipients were more likely to have lived in their dwellings for more than 5 years[12] compared to non-recipients with 89% of recipients living in their dwellings for less than 5 years compared to 99% of non-recipients, χ^2 (2)=61.88, p<.001.

12 This is affected by the fact that 10 EPC recipients have an EPC because their dwelling is 'for sale'. With these respondents removed a statistically significance difference remains and may reflect an error by respondents in terms of how long they have lived at their dwelling.

§ 5.6 Reported influence of EPC and context

§ 5.6.1 EPC possession and rating

The EPC sample consisted of 297 cases of which 10 had an EPC because they are selling their dwelling and 287 because they bought a house. 64.5% (185) stated that the EPC was made available to them when purchasing their dwelling but 35.5% (102) had to ask for the EPC. The main reason for asking for the EPC was an interest in the energy efficiency of the property (60%), followed by an understanding that it was a legal requirement (37%).

For those that had the EPC made available to them most saw it for the first time during the viewing (38.5%), followed by the notary's office (16%) and in the property advertisement (15%).

EPC ratings for the EPC sample group n = 287 are detailed in Fig. 5.1. Dutch policy typically targets dwellings with ratings lower than B, therefore, 83% of dwellings from this sample would be considered eligible for energy efficiency improvement.

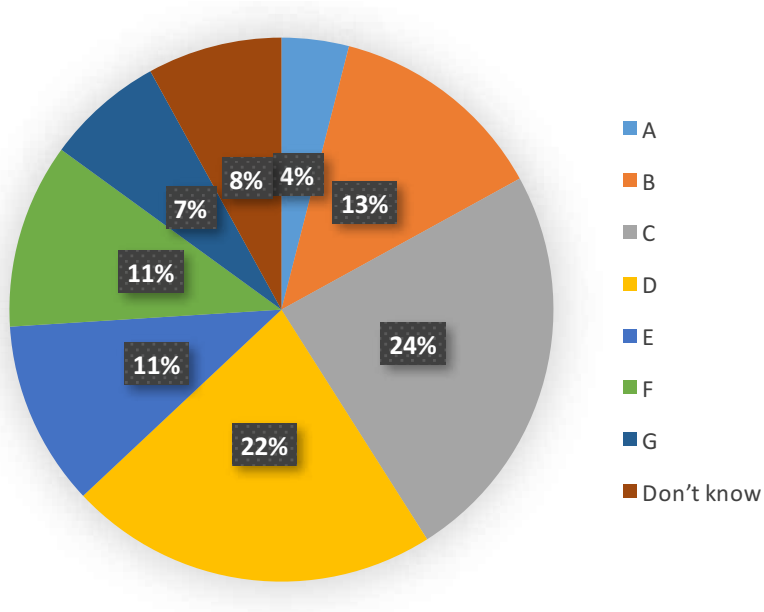

FIGURE 5.1 Energy ratings according to EPCs of the sample

§ 5.6.2 EPC influence at the point of sale

10% (29) (n=283) of the EPC sample group stated that the EPC influenced the property purchase. Of this 29, the EPC influenced decision to buy in 20 cases, influenced the sale price in 6 cases and influenced works carried out prior to occupation in 3 cases.

HOUSEHOLDS CHARACTERISTICS	RECIPIENTS		EPC NON-RECIPIENTS		STANDARDISED RESIDUALS *	P
	#	%	#	%		
Size						
1 person	52	19	137	15	**	.092
2	124	46	400	43.5	**	
3	37	14	160	17	**	
4	46	17	154	17	**	
4>	11	4	68	7.5	**	
Age						
20-39	118	40	385	37.5	**	.034
40-65	114	38	451	44	**	
66-79	26	9	49	5	<.05	
80>	2	<1	2	<1	**	
Not stated	37	12	140	12.5	**	
Education						
School	3	1	3	<1	**	.003
High School	8	3	32	3.5	**	
Lower vocational	4	1.5	7	<1	**	
Middle vocational	61	22.5	126	14	<.01	
Higher vocational	113	42	369	40	**	
University	80	29	368	40	<.05	
Other	2	1	9	1	**	
Employment						
Part-time	54	20	191	21	**	.002
Full-time	152	56	590	65	**	
Unemployed	10	4	21	2	**	
Retired	35	13	61	7	<.01	
Student	0	0	6	<1	**	
Other	7	7	38	4	**	

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HOUSEHOLDS CHARACTERISTICS	RECIPIENTS		EPC NON-RECIPIENTS		STANDARDISED RESIDUALS *	P
	#	%	#	%		
Monthly net income						
<1,000	2	1	1	<1	**	.019
1,000-1,350	6	2	17	2	**	
1,350-1,800	32	12	58	6	<.05	
1,800-3,150	91	34	312	34	**	
3,150>	87	32	347	38	**	
Not stated	50	19	175	19	**	
Duration of occupation						
<1 year	27	10	66	7	**	.000
1-5 years	213	79	835	92	**	
5>	29	11	11	1	<.001	
Plans to move						
Within 1 year	4	1.5	20	2	**	.251
1-5 years	33	12	77	8	**	
>5 years	37	14	136	15	**	
None	195	72	680	75	**	

*+Missing cases are respondents who do not complete the entire survey; * Based on chi-square test; **No statistical difference.*

TABLE 5.2 Household characteristics (including missing cases +)

§ 5.6.3 EPC influence post-purchase

22% (61) of respondents stated that the EPC influenced them in the adoption of energy efficiency measures post-purchase. Of these 61 cases: 87% stated that the EPC confirmed their ideas about some energy efficiency measures, 31% took more measures than planned as a result of the EPC and 20% took some measures that they previously had not thought of. Out of the 118 cases planning on taking measures 36% (43) planned on improving their EPC.

Results show a large percentage of recommendations were neither planned nor adopted (Table 5.3). Furthermore, a large percentage of measures were adopted and planned but not listed as recommendations. The most frequently adopted measure that was not recommended was boiler replacement while the most frequently planned measure that was not recommended was the installation of renewable technology.

§ 5.6.4 Non-recipients and EPC possession

14% (149) (n=1027) of the non-recipient sample that purchased a dwelling asked for an EPC but did not receive one. The main reasons for not receiving an EPC were that the estate agent stated the EPC was not required or it just was not made available even upon request.

This left a significant portion of respondents who did not request an EPC. The main reason for not requesting an EPC was that it simply was not considered necessary. A sizable percentage was put off by the fact that it was stated in the property advertisement that an EPC was not available. The third most common reason for not requesting an EPC was that the dwelling was considered adequately energy efficient.

MEASURE	RECOMMENDED	ADOPTED	PLANNED	% ADOPTED/PLAN COMPARED TO RECOMMENDED	NOT RECOMMENDED	
					ADOPTED	PLANNED
Boiler replacement	84	44	8	61	66	10
High performance glazing	122	43	13	46	47	17
Roof insulation	84	27	14	49	45	12
Floor insulation	99	32	14	46	35	21
Wall insulation	95	31	13	46	31	8
Heat recovery shower	1	1	0	-	4	3
Heat recovery m. ventilation	6	3	0	-	4	1
Insulation of piping	24	9	0	37.5	56	8
Draught proofing	42	17	6	55	64	19
Renewable technology	61	14	13	44	12	24

TABLE 5.3 Measures recommended, adopted and planned by EPC recipients

§ 5.6.5 Context: measures and funding

The two sample groups had similar motivations for adopting energy efficiency measures (Table 5.4). Energy bill reduction, comfort and 'end of life' of installations were the top three motivations among both EPC recipients and non-recipients for

carrying out measures. However, reasons for not adopting energy efficiency measures showed some differences. The main reason for not adopting energy efficiency measures among EPC recipients was lack of finances while for non-recipients it was consideration that their dwellings were adequately energy efficient.

Funding mechanisms are very similar between the two sample groups with savings being the most popular funding source for measures (Table 5.4). Mortgage arrangements were used by less than a quarter of respondents from both sample groups. Subsidies featured more strongly for the EPC recipients in being both a motivation for carrying out energy saving measures and a funding source.

	REASONS FOR ADOPTING MEASURES %											
	Reduce bills	Improve comfort	EoL of installations	Improve value	Subsidy	Poor EPC rating	EPC recommendations	Noise reduction	Experiment with technologies	Environmental	Advice-family/ friends	Other
EPC Recipients n= 202	84	77	32	30	25	21	15	15	4.5	4	3	10
Non-recipients n= 657	81	81	37	25	10	n.a	n.a	18	2	5	3	9.5
	REASONS FOR NOT ADOPTING MEASURES %											
	Lack of finances	Dwelling is efficient	Uncertainty -occupation	Not enough time	Don't know how	Hassle factor	It is unimportant	Other				
EPC Recipients n=74	49	27	12	8	7	5	1	30				
Non-recipients n=322	32	50	11	10	11	15	2	17				
	FUNDING OF MEASURES %											
	Savings	Special Mortgage	Loans –family/ friends	Normal loan	Special 'energy' loan	Subsidy	Other					
EPC Recipients n=201	78	20	3	6	2	21	9					
Non-recipients n=650	75	20	2.5	4	0.5	8	10					

TABLE 5.4 Reasons for adopting/not adopting measures and funding mechanisms (including missing cases+)

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§ 5.6.6 Statistical analysis of influence of EPC

67% of the non-recipients carried out an energy efficiency measure since moving into their dwelling with the equivalent percentage for EPC recipients 73% (Table 5.5). However, there was no statistical significance with having an EPC and carrying out energy efficiency measures,χ^2 (1) = 3.7, p > .05. Similarly, there was no significance with having an EPC and carrying out a greater quantity of energy efficiency measures χ^2 (8) = 3.25 p > .05. Neither was having an EPC and investing more financially in energy efficiency measures found to be statistically significant, χ^2 (4)=2.98, p>.05.

A statistical significance was identified with possessing an EPC and future plans to adopt energy savings measures. EPC non-recipients were more likely to state that they don't plan on adopting measures compared to EPC recipients, χ^2 (2) = 8.34, p < .05. A statistical significance was also identified for the amount the two samples plan to spend on future energy saving measures χ^2 (4) = 29.05, p < .001. Non-recipients were more likely to plan on spending more than €4000 and recipients were more likely to plan on spending €1000–€2000.

Analysis showed that, with the exception of wall insulation and the installation of renewable technology, there were no differences in the types of measures adopted by the two samples (Table 5.6). EPC recipients adopted wall insulation significantly more than expected, χ^2 (1) 12.02, p < .05 and renewable technologies significantly more than expected χ^2 (1)=7.69, p<.05.

VARIABLE	EPC RECIPIENTS N=297		EPC NON-RECIPIENTS N=1027		STANDARDISED RESIDUALS	P
	#	%	#	%		
Energy saving measures were adopted	202	73	663	67	**	.057
Number of energy saving measures adopted*						
One	48	24	162	25	**	.919
Two	52	26	164	25	**	
Three	35	18	121	18.5	**	
Four	30	15	93	14	**	
Five	16	8	56	9	**	
Six	8	4	29	4	**	
Seven	9	4.5	17	3	**	
Eight	1	<1	8	1	**	
Nine	0	0	1	<1	**	
Investment in energy saving measures						
>€4,000	81	40	264	41	**	.563
€2,000-€4,000	50	25	165	25	**	
€1,000-€2,000	34	17	113	17	**	
€500-€1,000	13	6.5	40	6	**	
<€500	23	12	68	10.5	**	
Energy saving measures are planned						
	n=274		n=960			
Yes	118	43	364	38	**	.015
No	50	18	257	27	<.05	
Don't know	106	39	339	35	**	
Estimated investment in planned measures						
>€4,000	24	20	110	30	<.05	.000
€2,000-€4,000	31	26	93	25.5	**	
€1,000-€2,000	30	25	84	23	<.001	
€500-€1,000	21	18	50	14	**	
<€500	12	10	27	7	**	

**Excluding 'other answers'; ** Not significant*

TABLE 5.5 Association between EPC and adoption and investment in measures

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MEASURE	EPC RECIPIENTS N= 276			EPC NON-RECIPIENTS N=988			P
	# ADOPTED	# NOT ADOPTED	% ADOPTED	# ADOPTED	NOT ADOPTED	% ADOPTED	
Boiler replacement	110	166	40	394	594	40	1.000
High performance glazing	90	186	33	308	680	31	.660
Roof insulation	72	204	26	230	758	23	.339
Floor insulation	67	209	24	192	796	19	.091
Wall insulation	62	214	22	137	851	14	.001
Heat recovery shower	5	271	2	7	981	<1	.150
Heat recovery m. ventilation	7	269	3	12	976	1	.156
Insulation of piping	65	211	24	212	776	21	.460
Draught proofing	81	195	29	307	681	31	.606
Renewable technology	26	250	9	49	939	5	.007
Other	23	-	-	84			

TABLE 5.6 Differences in the type of measures adopted

§ 5.7 Discussion

Results presented here confirm other research results that the EPC is a long way from policy aspirations expressed prior to its implementation. As with the research of Laine (2011), Watts et al. (2011), Amecke (2012) and Backhaus et al. (2011), a weak influence was identified for the EPC pre-purchase. A minority, 10% (29), stated that the EPC influenced their decision to buy their dwelling. Of this 10% (29), only 6 cases used the EPC to negotiate the price of the property.

Results also suggested weaknesses in implementation that have been highlighted elsewhere (see Tigchelaar et al., 2011). Of those who had an EPC, 64.5% had it made available to them, but a significant number, 35.5% asked for it to be provided. The majority of those who had the EPC made available to them viewed it at the stages intended for this instrument, either in the property advertisement or at the property viewing, 15% and 38.5% respectively. For 16% however it was made available at the notary stage when the opportunity to use the instrument in negotiations had passed.

Implementation issues surrounding the EPC are even more starkly apparent in the answers from the non-recipient sample. 14% asked for an EPC but did not receive one and 18% did not request an EPC because it stated in the property advertisement that it was unavailable.

Results also showed that the EPC still struggles for acceptance among some householders with 5% of the non-recipient sample reporting a negative impression about the EPC as the reason for not requesting one. However, this is less than reported by Tigchelaar et al. (2011) for their Dutch sample (over 30% of respondents reported a lack of trust in the EPC) and may reflect the improved EPC introduced in the Netherlands in 2010. Further details about how the EPC is valued were obtained from results showing that 3% didn't request an EPC because they planned to renovate their dwelling and 4.5% stated that they were aware that the dwelling, because of its age, was inefficient and therefore they did not consider an EPC useful. Interestingly, this 7.5% did not exploit the potential value of the EPC in offering them professional insight into the energy efficiency possibilities of their dwelling. This lack of value associated with the EPC is starkly emphasised by over half of non-recipients not requesting an EPC because they did not see it as necessary. A positive result about the value of the EPC among the EPC recipient sample was that 36% (43) of those planning on carrying out energy efficiency measures plan on improving their EPC.

In percentage terms the EPC had a greater influence on householders post-purchase with 22% (61) stating that the EPC influenced them to carry out energy efficiency measures. For the majority of these respondents the main influence of the EPC was to confirm their ideas about some measures while a smaller number stated that they carried out more measures because of the EPC or carried out some measures that they had previously not considered.

Analysing the differences between the EPC recipient sample and the non-recipient sample revealed a weak influence of the EPC. There was no statistical significance with possessing an EPC and carrying out energy efficiency measures. Statistical significance was found for the installation of wall insulation and renewable technology and possession of an EPC. Additionally, non-recipients were more likely to state that they were not planning on future energy efficiency measures compared to recipients. These results may stem from the fact that EPC recipients were more likely to live in older dwellings compared to non-recipients but it may relate to the EPC bringing awareness of less well known energy efficiency measures to the EPC recipient sample.

Previous research on the EPC highlights a paradox that is supported by research presented here. On the one hand Brounen and Kok (2010) and the Department of the Environment Water Heritage and the Arts (2008) suggest that dwellings with higher energy ratings have a higher market value. On the other hand, research by Backhaus et al. (2011) and Laine, 2011 found that few buyers use the EPC during negotiation. Similarly, research presented here found that few householders used the EPC during the transaction process. However, a third of EPC recipients who adopted energy efficiency measures reasoned that they did this to improve the value of their property. Among the non-recipient group, a quarter reasoned that they took energy efficiency measures to improve the value of their property. While potential buyers are unlikely to

negotiate on the basis of an EPC rating or energy efficiency a significant portion appear to appreciate that energy efficiency offers value to a property.

Results presented here support criticisms of the barrier model of conceptualising what drives householders to act, or not, on energy efficiency measures. This is clearly displayed when comparing the energy efficiency measures adopted or planned to those recommended which show that a very significant portion are ignored, close to 50% for most recommendations. Moreover, results show a large number of measures that are adopted or planned that were not recommended in the EPC. Overall, there is very little difference between the energy efficiency measures adopted by EPC recipients and non-recipients. All of these findings question the role of the EPC in identifying appropriate energy efficiency measures but also the motivations behind householder investment behaviour.

Furthermore, while householders frequently cited financial barriers, lack of action due to apathy remains the elephant in the room. 51% of the non-recipient sample did not request an EPC because they did not consider it necessary. Moreover, 27% of EPC recipients and 50% of non-recipients did not carry out energy efficiency measures because they consider their dwellings to be energy efficient. This is despite over 80% of EPC recipients living in dwellings rated below B and with over 50% of EPC recommendations for insulation being ignored. With 80% of the non-recipients living in dwellings constructed before 1990 it is assumed that significant energy saving potential remains within their dwellings.

A number of limitations characterise research results presented here. As with much research in this domain problems with representativeness were encountered. The recipient and non-recipient samples differed in a number of key areas which hampers direct comparability. Nevertheless, statistical analysis of the energy efficiency investment action of recent homeowners, those with an EPC and another without, is considered to offer insight into how the EPC functions and complements data on how the two groups reported their experiences with the EPC. Moreover, although the survey was distributed to a large number of addresses from the EPC database, respondents who received an EPC because they bought a dwelling remained a minority. This further highlights the need to create comprehensive formal monitoring and evaluation programmes for the instruments that define policy efforts for the existing housing stock. Such a monitoring and evaluation program could also offer valuable data on how the acceptance and effectiveness of instruments like the EPC change as the instrument matures.

§ 5.8 Recommendations

Based on the results of EPC recipients pre and post-purchase it is suggested that even if fully implemented the EPC as it is now will not have the impact intended. Research results presented here offer further empirical support to the argument that the EPC must be integrated within a framework of instruments that work together to improve energy performance of existing dwellings (Sunikka, 2006; Parnell and Popovic Larsen, 2005; BELAS, 2001; IMPACT, 2005). Similar to recommendations during ex-ante assessments it is suggested that the EPC and its recommendations act as a launch pad for more sophisticated mechanisms to drive energy performance improvement.

With the focus on the target group presented here, recent dwelling purchasers, one way to use the EPC as a launch pad for durable and objective energy based renovation is to link cost effective recommendations issued in the EPC to mortgage options. While respondents to this questionnaire had recently purchased their dwellings only 20%, from both sample groups, used their mortgage as a mechanism to fund energy efficiency measures. This is despite the fact that the first years of ownership appear prolific for the adoption of measures. Moreover, a sizable portion of the non-recipients stated their intention to carry out intensive renovation work yet no instrument comes in to play at this point to encourage deep energy based renovation. That over a third of EPC recipients claim that they will improve their energy rating when adopting measures in the future shows that the EPC can encourage a package approach to adopting energy saving measures rather than single measures. There are vast opportunities for more sophisticated approaches to mortgages that can maximise energy efficiency measures at the crucial but neglected trigger of dwelling purchase.

Results presented here support the argument that the barrier model is too simplistic as a means of developing instruments for existing dwellings. Both the number of recommendations that are ignored and the number of energy efficiency measures that are adopted or planned but not recommended in the EPC suggest much more nuanced investment behaviour than conceptualised through policy instruments. Added to this are the large number of respondents who consider their dwellings to be adequately energy efficient when it is known from EPC data that potential remains. Together these findings lead to a recommendation that much more clarity is required on what represents an energy efficient dwelling. On the basis of such clarity is a need for much stronger mix of instruments that determine the energy efficiency potential of a dwelling objectively and on the basis of climate change policy. This is opposed to the current situation which leaves determination of an adequate level of energy efficiency entirely to householders.

Further research into the policy instruments that can effectively trigger the energy saving potential of existing dwellings remains a priority. It is widely accepted that instrument combinations are required to deal with the many barriers and opportunities surrounding energy performance improvement of dwellings. However, theorising and practical examples of instruments that can work together to remove the information deficit, instil energy efficient dwellings with greater market value and trigger deep retrofit is much needed.

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6 The policy instruments of European front-runners: effective for saving energy in existing dwellings?

Abstract

Existing dwellings receive frequent attention in climate change policy given the wealth of cost-effective, but un-exploited, energy saving potential within their walls. Policy attention also recognises the need for instruments that can navigate around barriers and maximise opportunities to achieve deep carbon reductions. However, there is a lack of evidence and knowledge about the instruments that can boast of success. In response to this knowledge gap, the instruments that form the main policy response to reduce energy consumed for space and water heating in existing dwellings in several front-runner European countries are assessed. Aims are to include, and to go beyond, an understanding of effectiveness based on reported reductions in CO_2 emissions and/or monetary savings on energy bills. Effectiveness is also judged on the basis of how instruments reflect policy instrument and energy policy concepts drawn from literature. Results show that the instruments that define action of front-runners differ significantly. Front-runners fail to reconcile all the identified concepts in their main instruments but some feature strongly. In this regard, selected countries established their main instruments over two decades ago, reflecting the concept of long-term instrument development and support. However, few front-runners adequately monitor and evaluate instruments to illuminate cause and effect. Front-runners struggle to diversify their core instrument approaches to capture 'hard to reach households' such as the private rental sector and lower-income households. The divergence in the instruments that form the main policy response of front-runners allows for the characteristics of a range of instruments to be analysed including regulations, information tools, taxes and incentives.

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§ 6.1 Introduction

The unparalleled energy saving potential of existing dwellings is widely established (BPIE 2011; McKinsey and Company, 2009; Schröder et al., 2011; Ürge-Vorsatz et al., 2007). However, evidence of policy instruments that tap into this potential is much less publicised. While building regulations form the instrument of choice for new build, an equivalent type of 'keystone' instrument for existing dwellings is less observable. Instead, the traditional approach to energy saving in existing dwellings revolves around economic incentives and information tools with numerous reports highlighting scope for improvement (Boardman, 2007; Höhne et al., 2009; WBCSD, 2009). Moreover, according to the European Commission (2011), market and regulatory failures are causes for the EU falling short on progress towards the 2020[13] energy efficiency target. This casts the spotlight on, inter alia, the types of instruments charged with meeting this target.

To gain greater knowledge of the type of instruments associated with success in meeting climate change targets for existing dwellings, a comparative study of several front-runner countries, Denmark, Germany, Sweden and the UK, was carried out. Countries were chosen based on their classification as front-runners according to literature. The instruments that define the main national action to existing dwellings were drawn from documentary sources and confirmed with national experts. Research objectives are to: (1) identify and characterise instruments considered as effective and (2) identify if and how energy policy and instrument design and evaluation concepts are reflected in instruments. Therefore, 'effectiveness' of instruments is interpreted as both the documented results of goal achievement and the extent to which instruments deal with aspects unique to this policy domain.

Literature from comparative public policy was used to structure research for the first objective (Rose, 2001). This literature provided guidance on how to choose cases for comparative study. Document analysis was carried out to characterise instruments reported as effective. To meet the second objective, the main instrument(s) used by front-runners were assessed against concepts from literature. Results from document analysis and instrument assessments based on concepts were verified with national experts (See Appendix 4).

A fundamental goal of this research was to deepen understanding of the content, mechanisms and scope of policy instruments. This responds to a research gap, 'the

13 European Union Member States are committed to 2020 targets: obligatory 20 % reduction in greenhouse gas emissions and 20 % increase in energy from renewable sources and an indicative 20 % improvement in energy efficiency.

purpose of almost all evaluations [i]s to measure the energy savings and cost... As a result, there has been almost no discussion in the global literature on energy efficiency about general principles ...' (Fairey and Goldstein, 2006, p. 8–64). Moreover, the purpose of many best practice studies appears to be describing the instruments of other jurisdictions as if the interest is replication. Using concepts from literature is an effort to go beyond traditional cost-efficient and cost-effective evaluations by searching for how instruments tackle, or fail to tackle, salient issues in this policy domain.

§ 6.2 Approach

§ 6.2.1 Policy instruments and data collection

Taking policy instruments as a variable for analysis receives support from a range of public policy commentators (Bemelmans-Videc et al., 1998; Eliadis et al., 2005; Linder and Peters, 1989; Howlett, 2010). Policy instruments can be defined as the concrete and specified operational forms of intervention by public authorities (Bemelmans-Videc et al., 1998, p. 4). Instruments are viewed as the means of overcoming market barriers or in terms of effect on the target group. Commentators, including Schneider and Ingram (1990) and Salamon (2002), discuss instruments in terms of influence on behaviour. In this way, an instrument can be conceived as the means 'to get people to do things they otherwise would not have done or it enables them to do things they might not have done otherwise' (Schneider and Ingram, 1990, p. 510).

To isolate tools for analysis, the instruments of front-runners were screened from a range of sources including comparative studies (e.g. Hamilton et al., 2010), National Energy Efficiency Action Plans (NEEAPs) (required by the European Energy Services Directive), assessments/reviews of NEEAPs (EEW, 2009; EC, 2009) and country reviews by the International Energy Agency (IEA). Instruments identified as defining action were isolated for deeper analysis. Sources used for the in-depth analysis included EU project reports and evaluations, national evaluations and peer- reviewed articles. It was decided to limit the study to the instruments that really define policy attention to existing dwellings for a number of reasons. Considering that there is a wide range of instruments in operation in different countries, a choice was made between seeking breadth or depth. What is more, it was discovered that there is often not enough data to fully characterise and assess the full range of instruments. It was further decided to limit the study to instruments aimed at reducing energy consumed

for space and water heating as this makes up approximately 70 % of residential energy use) (Itard and Meijer, 2008). The instruments analysed as part of research presented here are listed in Table 6.1.

	ECONOMIC INCENTIVES	ECONOMIC DISINCENTIVES	REGULATIONS	INFORMATION TOOLS
Denmark			Building Regulations	EPC
Germany	KfW loans & subsidies			
Sweden	Subsidies	Energy & CO_2 taxes		Local Energy Advisors
UK	Supplier Obligations			

TABLE 6.1 Instruments considered to dominate action in front-runner countries

It is emphasised that the instruments listed in Table 6.1 are not unique to any particular front-runner. Denmark also operates a Supplier Obligation, and many countries operate incentives and loan schemes, taxes and information tools. Under the requirements of the Energy Performance of Buildings Directive, all Member States have minimum requirements for major renovation and a requirement that the EPC is issued for dwellings during construction, sale and rental. However, some countries invest more in a particular instrument, state that the majority of energy savings are expected from certain instruments or implement instruments in a unique way. It is these instruments that form the focus of this study.

To verify and expand data obtained from secondary sources, national experts from the selected front-runners were sent questions relating to the characterisation of the policy instrument approach and results for each assessment concept (see Appendix 4). Phone interviews were held with experts from each front-runner case during Autumn/Winter 2011 to discuss results and finalise conclusions. Email correspondence formed an additional source of information for Germany, Sweden and the UK.

§ 6.2.2 Comparing and selecting countries

Comparing and learning from other jurisdictions is well established in policy analysis (Dolowitz and Marsh, 2000; James and Lodge, 2003). Comparing the instruments used by front-runners forms an evidence-based means of developing ideas and provides a window to possibilities, otherwise hidden by institutions, cultures and social structures (Rose, 2001). This window is considered especially useful in cases where the same instruments are used in many countries but appear to excel in some.

To identify front-runners, academic and policy documents on environmental policy in general and energy policy in the building sector in particular were examined (for example, Jordan and Lenschow, 2000; Liefferink and Andersen, 1998; EC, 2009; EEW, 2009). A review of instruments in operation in front-runner countries was conducted before: Denmark, Germany, Sweden and UK were selected for comparison. Front-runner countries are viewed as a fruitful base for learning and are defined as countries that set regulatory trends in policy fields (Jänicke, 2005, p. 130).

§ 6.2.3 Assessment concepts

Literature on policy instruments, policy design and evaluation, energy policy, market transformation and diffusion illuminate a range of concepts that can be used as a normative guide for assessing instruments. These are listed below and further elaborated:

- Instrument combination
- Long term framework
- Incentivising/obligating balance
- Target group differentiation
- Primacy to energy efficiency
- Whole house approach
- Energy sufficiency

  - *An instrument combination* is based on policy instrument literature and theories such as smart regulation which state that instruments should be chosen to interact and to maximise strengths and offset weaknesses of individual tools (Howlett, 2004; Gunningham et al., 1998; cited in Howlett, 2010). Furthermore, in terms of energy efficiency policy, multiple barriers require the combined effect of the instruments (WBCSD, 2009). Gunningham et al. (1998) discuss combinations as being negative and neutral. In the context of this analysis, the instruments considered to form the main action towards existing dwellings are assessed in terms of whether they form a strategic combination with other instruments.

  - *Long-term framework* is based on market transformation and diffusion theory and is considered necessary to 'embed' energy efficiency, transform the market and allow support for higher levels of energy efficiency (Fairey and Goldstein, 2006). A key factor considered necessary for market transformation is that long-term funding or supportive regulatory policies, but ideally both, are supported and sustained in effort over time until the market can sustain itself without public funding (Fuller et al., 2010). In the context of this research, the longevity

of instruments in terms of how long they have been active and the future planning of instruments is assessed.

- *An incentivising and obligating* balance follows the notion that policy should represent a 'give-and-take strategy', that a restrictive instrument should be combined with a stimulative one (cited in Bemelmans-Videc et al., 1998). In the context of this research, the instruments that dominate action in front-runners will be examined in terms of whether such a dynamic is evident.

- *Target group differentiation* is based on the idea that the target group represents a range of diversity differentiated by, inter alia, income level, housing quality, knowledge and awareness and potential to innovate. Two particularly 'hard to reach groups' in this domain are lower-income households and the private rental sector who face barriers of upfront investment and the split incentive, respectively (Boardman, 2007). As a result, bespoke instruments or mechanisms within instruments are required to reach these groups. Added to the barriers particular to these groups is that dwellings in these categories are frequently of the lowest energy efficiency which heightens the need for deliberate targeting. In the context of this research, the extent to which the dominant instruments account for this diversity, and if not what alternative instruments are used, is examined.

- *Primacy to energy efficiency* is based on the notion that the most energy-efficient and cost-effective approach is to provide an energy-efficient built envelope which dictates further requirements in terms of heating and cooling installations (Rovers, 2008; ECEEE, 2010). Whether the instruments that dominant action in the chosen front-runners follow an approach to energy saving that gives primacy to energy efficiency will be examined, for example, is an efficient building envelope a condition for a subsidy for a micro-generation technology?

- *A whole house approach* is receiving increasing popularisation given the ambition of climate change policies. Ambitious targets lead to arguments that instruments supporting single energy performance measures will be ineffective. Instead deep renovation drawing on a complete range of energy-saving measures is required (Mlecnik et al., 2010; Hamilton et al., 2010). This is especially the case when long-range targets to 2050 are discussed, in which case it is expected that emissions from the building sector will have to be reduced by 90% (BPIE, 2011, p. 99). When analysing the instruments of front-runners, whether they work towards single measures or whole house renovation will be examined.

– *Energy sufficiency* is interpreted as the desired end point of policy instruments, which is interpreted as a reduction in absolute energy use. However, often the implementation of an instrument or adoption of an energy saving measure by a householder is considered the end point (Wilhite and Norgard, 2003). Therefore, effective monitoring and evaluation of instruments and intended outputs are critical components to link cause and effect and to ensure instruments are sufficient for goals. This is especially necessary considering that energy use at household level and actual effects of energy-saving measures on household energy use remain imperfectly understood (Guerra Santin, 2010). This concept will be applied to the assessment that follows by examining whether the instruments of front-runners are associated with monitoring and evaluation programmes.

§ 6.3 Policy instruments of front-runners

The instruments considered to dominate national/federal policy action for existing private dwellings are presented here. Based on secondary sources, instruments are characterised in terms of content and effects. Drawing on secondary sources and using interviews and correspondence with national experts the dominant instrument approaches are assessed against the seven assessment concepts listed below:

– Instrument combination
– Long term framework
– Incentivising/obligating balance
– Target group differentiation
– Primacy to energy efficiency
– Whole house approach
– Energy sufficiency

If a concept is considered to be partly represented by the main instrument approach, it is assessed as weak; if a concept is explicit in policy documentation relating to the instrument, it is assessed as moderate and if a concept is made explicit and has associated results, it is assessed as strong. The assessment of all countries is displayed in Fig. 6.1.

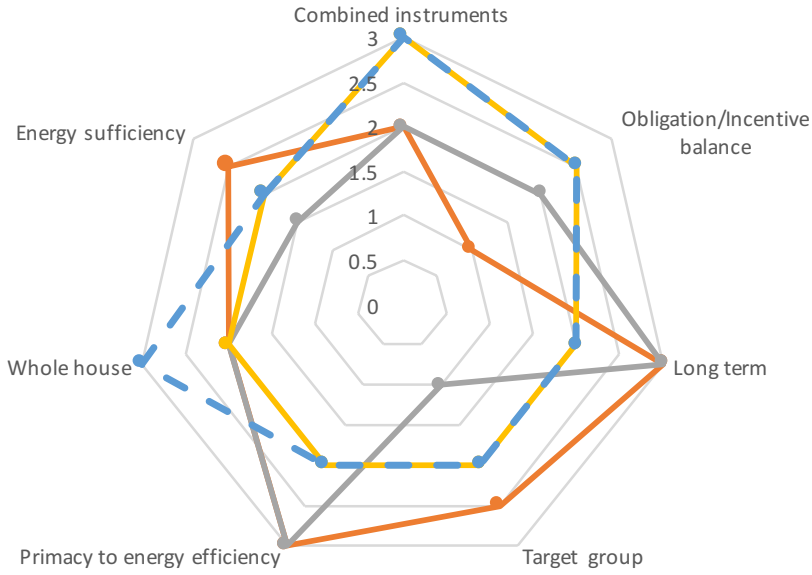

FIGURE 6.1 Assessment chart.
Scores: 0: absent; .5 transitional; 1: weak (concept partly represented); 2: moderate (concept explicit in policy documentation);3: strong (concept explicit with results)

§ 6.3.1 Denmark

§ 6.3.1.1 Policy background

Danish 2020 climate change goals include a 30% reduction in greenhouse gas emissions, 30% share of renewables and a 4% reduction in energy consumption from 2006 levels (DMCE, 2011, p. 8). A long-term goal is fossil fuel independence by 2050 with a ban on installing oil heaters in existing dwellings from 2017 forming part of this action (ibid). Taxes on energy and CO_2 emissions play a role in reducing energy consumption (Togeby et al., 2009). In the future, simultaneous strengthening of regulations for building components and obligations on energy companies are likely to play a greater role (DMCE, 2011). Strengthening of building regulations for renovation and installation replacement and improved functioning of the Energy Performance Certificate (EPC) form the current central instrument responses for existing dwellings (Hamilton et al., 2010; DMTE, 2005). It is planned that this approach will lead to a saving of 25% of current energy use compared to 2005 regulations (Hamilton et al., 2010, p. 49). It is these two instruments that form the focus of this assessment.

§ 6.3.1.2 Building regulations

Content The 2010 Building Regulations issue a comprehensive suite of component u value requirements required during conversion, or alteration of individual building components (DMEBA, 2010). Given that most countries typically issue regulations for existing dwellings during 'major' renovation, this can be considered more ambitious than the norm. Requirements respect a definition of cost effectiveness based on a calculation[14], which means that the energy-saving measure must pay for itself within 75 % of its expected lifetime (DMEBA, 2010, p. 136). As well as these 'non-major' renovation requirements, building regulations follow the definition of major renovation recommended in the EPBD[15]. In the case of single-family houses, regulations during major renovation only apply to the part of the building undergoing renovation; for all other cases, regulations apply to the complete building. A link with the EPC is evident as the measures considered cost-effective during renovation as well as outside renovation activity are listed therein.

Effects Research identifies a considerable potential for renovation such that 30–35% of energy used for heating could be saved offering a reasonable payback time (Gram-Hanssen and Christensen, 2011). Whether this effect is reached is not precisely known due to a lack of monitoring and evaluation. Although a large-scale evaluation was conducted of the national energy efficiency portfolio in 2008, building regulations and the impact on existing dwellings do not appear to have been included. Expert opinion and secondary sources note that while impacts are not attributed to regulations with high precision, the opinion is that they have a strong market effect especially in terms of the development of innovative products (Hamilton et al., 2010).

§ 6.3.1.3 Energy Performance Certificates

Content EPCs were introduced to Denmark in 1997 predating their introduction through the Energy Performance of Buildings Directive (EPBD) and exceeding directive requirements in ambition (Togeby et al., 2009). For example, EPCs are valid for 5 years instead of 10 required by the EPBD. Additionally, recommendations in EPCs follow two trajectories: immediately feasible measures and measures feasible during a major renovation.

14 Measures are considered cost-effective if annual saving multi plied by the lifetime divided by the investment is greater than 1.33 (DMEBA 2010, p. 136)

15 ".. building works on the building envelope or installations which effect more than 25 % of the building envelope, or whose value is higher than 25 % of the value of the latest public property valuation, excluding the value of the plot" (DMEBA 2010, p. 140).

The EPC in Denmark has suffered from well documented implementation issues. In 2007–2008, it was estimated that 50–60 % of properties sold had EPCs (cited in Gram-Hanssen and Christensen 2011, p. 12/13). Although mandatory, EPCs were not associated with any particular promotion campaigns perpetuating a situation of low awareness (Joosen and Zegers, 2006). Empirical research demonstrates the importance of building and sustaining a good reputation in the energy certification system (Gram-Hanssen et al., 2007). However, a feeling that EPCs were too expensive and unreliable was pervasive (Joosen and Zegers, 2006). Negative media attention created scepticism among the public, with, for example, EPC recommendations considered as 'copy and paste' efforts (Gram-Hanssen et al., 2007). Furthermore, key stakeholders such as estate agents were said to have been unsupportive of implementation (Laustsen and Lorenzen, 2003).

Effect Research on the effects of EPCs is at best inconclusive. One study found that EPCs had an impact on investment priorities with more technically demanding improvements conducted on dwellings with EPCs than those without (Laustsen and Lorenzen, 2003). Analysing impact in terms of actual energy use showed that dwellings with EPCs did not demonstrate reduction in gas use over dwellings without but whether renovation work had taken place was not factored in (Kjærbye, 2008). In terms of an effect on property marketability, 38 % of a sample of Danish householders who received an EPC considered it important or very important in making an offer (Adjei et al., 2011, p. A264). Meanwhile, 11 % used the EPC during price negotiation (ibid).

The comprehensive evaluation of the national energy efficiency portfolio in 2008 concluded that the EPC was not cost-effective (Togeby et al., 2009). This conclusion was based on aspects such as the €650 cost for the EPC often for householders not interested or ready to receive the information (ibid) and supported by data from the Kjærbye (2008) study stating that gas use between dwellings with an EPC and without was undifferentiated.

§ 6.3.1.4 Assessment concepts

The *policy instrument combination* concept is charted as 'moderate' in Fig. 6.1. Combined instrument action exists between the EPC and building regulations with, for example, EPCs required after major renovation. Nevertheless, these instruments do not form a powerful positive combination especially considering the EPC, for a large part of the housing sector, does not seem to guarantee energy savings. Using the typology of interactions of Gunningham et al. (1998), the combination could be considered neutral.

The *obligating/incentivising balance* is also judged as 'moderate'. While obligations are considered strong with component requirements even for 'non-major' renovation, this concept is weakened by the absence of an incentivising balance. According to a national expert, this may change in the future with proposals for incentives like green loans in response to the 2050 Energy Strategy.

Clear and strong elements of a *long-term strategy* are in place with a mandatory EPC introduced in 1997 and a clear role for existing dwellings in building regulations. The dominant instruments are grounded in legislation securing their persistence. The 2050 Energy Strategy provides a long-term view giving preparation time to the market. As a result, the long-term concept is plotted as 'strong'. As can be expected from instruments rooted in the transaction and renovation processes, there is no *differentiation of the target group*. Furthermore, according to a national expert, there are currently no complementary instruments used for 'hard to reach' groups. As a result, this concept is plotted as 'weak' in Fig. 6.1.

Danish support of component level requirements in building regulations demonstrates that thermal performance of the building envelope is central. As a result, *primacy to energy efficiency* is plotted as 'strong'. However, building regulations and the EPC focus on a single measure-based approach. During an expert interview, it was noted that promotion of the *whole house perspective* takes place but it remains a major challenge to integrate it into an instrument while respecting the economic capability of householders. As a result, the whole house concept is charted as 'moderate'.

Whether energy consumption is actually reduced because of instruments is touched upon in evaluations but not consistently monitored. While a comprehensive evaluation of instruments was conducted in 2008, it was based largely on cost effectiveness. It remains that instruments lack clear and consistent monitoring frameworks to prove cause and effect. Although this cause–effect precision is lacking, a national expert reported correlation between building regulations and energy consumption reduction as strong. As precision is lacking about whether instruments directly lead to expected savings the concept of energy sufficiency is plotted as 'moderate'.

§ 6.3.2 Germany

§ 6.3.2.1 Policy background

Germany's climate change targets include a 40% reduction of GHG emissions with a 1990 baseline, 20% reduction in primary energy consumption and building heating energy use with a 2008 baseline and an 18 % share of renewable energy generation by 2020 (OECD/IEA, 2008). To meet targets, an estimated 20 million dwellings require renovation by 2020 (KfW Bankengruppe, 2010). In response, one estimate is that the thermal retrofit rate will have to increase from 0.8 to 2% per year (Neuhoff et al., 2011, p. 3). A range of instruments are in place to reach these targets; however, the dominant policy instrument for existing dwellings is the economic incentive programme operated by the federal development bank Kreditanstalt für Wiederaufbau (KfW) (Rosenow, 2011). KfW loans and grants are coordinated with federal incentives for energy advice and building regulations (Energy Savings Ordinance, EnEV) and are specifically geared to bring existing dwellings in line with, or beyond, new build standards. Alongside this, the EnEV issues component-based regulations during the renovation trigger as well as general retrofit stipulations, for example, insulating un-insulated heating pipes (Engelund-Thomsen et al., 2009). Furthermore, EnEV contains an option of meeting 140% of the energy requirement of new build instead of component requirements during renovation. This comes close to a form of energy performance standard for existing dwellings.

§ 6.3.2.2 KfW incentives

Content Since 1996 KfW loans have targeted energy efficiency in pre-1979 buildings (Korytarova, 2006, p. 7). According to a national expert, funding has traditionally been announced on an annual basis although from 2011 funding was secured at €1.5 billion annually until 2014. Terms and conditions of loans are viewed as highly attractive; they are long term, pre-payment is possible without extra charges and combination with other incentives is possible (Hamilton et al., 2010). In 2011, interest rates were approximately 2.30–2.85% depending on the contract period (Rosenow, 2011, p. 264) approximately 1 to 2% lower than contemporary market rates.

Five levels of loans are available for the 'KfW Efficiency House' standard. The most ambitious is KfW Efficiency House 55 which represents 55% of the maximum primary energy requirement as specified by regulations for new build (KfW Bankengruppe, 2011). Repayment bonuses form an additional strong incentive; for example, 12.5%

is taken off a loan if KfW Efficiency House 70 is achieved (ibid). KfW incentives offer considerable subsidisation of energy based retrofit. Neuhoff et al. (2011, p. 8) found that one third of the incremental costs to reach new build standard are subsidised and one half if 55% of the standard is reached. In the event that a particular level cannot be achieved, financing is available for single energy saving measures.

Effects The KfW programme has achieved some impressive results. Since 2006, approximately 2.2 million tons of CO_2 emissions have been saved annually with 188 million € saved on household bills (Hamilton et al., 2010, p. 62). From 1990 to 2006, CO_2 emissions from existing dwellings were reduced by 24%, a reduction largely attributed to the KfW programmes (cited in Schröder et al., 2011, p. 10). However, whether free rider and rebound effects are reflected in these figures is not mentioned. Furthermore, doubt about whether incentives are adequate to reach the 20 million dwellings requiring retrofit by 2020 has been aired (Hamilton et al., 2010; Schröder et al., 2011). Previous years have witnessed approximately 230,000 dwellings per annum being reached by KfW financing (cited in ibid, p. 68) lower than expected to reach the 2020 target. While there is doubt in terms of scope, few appear to question the ambition of this instrument. According to a national expert in the first half of 2011, almost 40% of loans for the 'KfW Efficiency House' were for renovations pledging to go beyond new build requirements. The cost effectiveness of this ambition, however, has been questioned. Galvin (2010) argues that achieving the lower standards offered by the KfW programme is considerably more cost-effective in terms of energy saved per euro invested and in terms of return on investment over the lifetime of renovations than reaching for the higher standards.

§ 6.3.2.3 Assessment concepts

In terms of the first concept of a combined instrument approach, the synergistic relationship with KfW incentives stimulating renovation beyond minimum building regulations is plotted as 'strong' in Fig. 6.1. The second concept of an *obligating/ incentivising balance* is considered 'moderate to strong' given that building regulations not only issue requirements during the renovation trigger but also issue general retrofit requirements for some components with incentives available to reach these through KfW loans for individual measures.

The *long-term framework* concept is listed as 'moderate', although in operation since 1996 there is some uncertainty about funding beyond 2014. Funding has been typically announced annually although currently there is guaranteed funding until 2014. However, Rosenow (2011) highlights the vulnerability of this instrument to political change noting for example that budgetary constraints reduced funding in 2010.

The *target group differentiation* concept is plotted as 'moderate' as the often marginalized private rental sector is reached, but uncertainty remains about whether lower income groups are reached. Private homeowners are the main recipients of KfW loans at 41% with private landlords at approximately 33%, figures that generally reflect the tenure division (KfW Bankengruppe, 2011). According to a national expert, repayment bonuses are considered an incentive for sub-groups such as private landlords. The comparatively high supply of private rental dwellings also results in competition between private landlords which may explain how this tenure group is motivated to improve energy efficiency (Schröder et al., 2011). Less obvious are participation rates of lower-income householders. Fuel poverty is not a strong policy discussion point in Germany (Rosenow, 2011). According to a national expert, KfW do not request and/or collect data on income profiles. This is because loans relate to the energy performance potential of the building and not the financial capacity of the applicant. However, Galvin (2010) notes in his study that the substantial investment required by householders to meet ambitious standards precludes the participation of lower income householders.

Primacy to energy efficiency is recorded as 'moderate'. While a holistic approach to energy performance with a starting point of energy efficiency is explicitly supported by the different KfW Efficiency House levels support for single measures within KfW does not depend on a building envelope thermal standard. Meanwhile, the whole house approach is considered 'strong' as it is explicit in the KfW Efficiency House levels. While single measures are supported with KfW finance, this is in response to economic difficulties of reaching KfW Efficiency House levels in some dwellings. Moreover, applicants following the 'Efficiency House' approach receive more generous funding than those following the single measure approach (Schröder et al., 2011).

The *energy sufficiency* concept is plotted as 'moderate' given some uncertainty about actual versus theoretical savings. A number of evaluations show that energy savings have been achieved with the KfW scheme (see Rosenow, 2011). A national expert confirmed that recipients of KfW incentives must confirm that measures have been carried out but actual energy consumption is not monitored.

§ 6.3.3 Sweden

§ 6.3.3.1 Policy background

The IEA described Sweden's energy policies as 'sound and sustainable' (OECD/IEA, 2008, p. 27) with an objective of reducing energy consumption per unit of heated area in homes by 20% by 2020 and 50% by 2050 with a 1995 baseline (Ministry of Sustainable Development, 2006). Sweden is frequently promoted as a model country in terms of decoupling economic growth from environmental degradation (Fouche, 2008). A key role in this reduction is attributed to a decentralised energy supply focused on conversion of electric and oil-fired boilers to district heating, heat pumps and biofuel-fired boilers. In addition, district heating has changed from fossil fuels to biofuels with increased heat recovery from waste (Ministry of Sustainable Development, 2006). This reflects a typical focus in Swedish energy policy on supply side issues (Khan, 2006; Kiss and Neij, 2011). Alongside accolades, commentators note complacency in Swedish policy which they see as a reaction to CO_2 emissions being considerably lower than European counterparts (McCormick and Neij, 2009).

The 2011 National Energy Efficiency Action Plan states that the "task of government policy is to identify and eliminate 'market failures', principally externalities and a lack of information" (SOU 2011, p. 8). This is reflected in the two policy instruments that, on the basis of literature review and expert interview, are considered to characterise Sweden's approach to energy performance improvement in existing dwellings: economic tools-subsidies and taxes and information tools -local energy advisors

§ 6.3.3.2 Economic tools

Overview Economic incentives have played a consistent role in Swedish residential energy policy since the 1970s and are primarily developed to support new technology or systems (McCormick and Neij, 2009). From 1977 to 2010, 16 national economic incentives are reported and 1994 appears to be the only year that some form of incentive was not in place (cited in ibid, 2009, p. 9–10). Incentives from the 1970s to the turn of the century typically focused on insulation measures and ran for 1 to 2 years (ibid). From 2000, incentives focused on supporting conversion to more sustainable energy sources in particular to biofuel boilers, heat pumps, solar heating systems and district heating (ibid). More recent incentives operate over longer time frames—3–5 years. Incentives manifest as grants and tax exemptions and commonly cover 30% of investment costs (ibid). Current incentives (2011) include a 50% tax relief on renovation work for properties

older than 5 years and a subsidy for solar heating systems (SOU, 2011). While the tax relief programme covers energy performance work, the main intended effect is to reduce black market labour. Reaction to problems in the construction sector as opposed to proactive energy conservation is said to underpin many subsidies 'when unemployment disappeared so did the support schemes' (cited in Sprei et al., 2006). Two taxes work towards reducing or influencing more sustainable energy use in Swedish households (Nair et al., 2011). An energy tax based on per unit use and a CO_2 tax based on carbon content with biofuels and peat exempt (ibid). It is aimed that the CO_2 tax contributes to the three goals of greenhouse gas reduction, increase in renewable energy generation and energy efficiency (SOU, 2011). Since its introduction in 1991, the CO_2 tax has increased fourfold from €27 to €100/ton CO_2 in 2001 (Nair et al., 2011, p. 7–472).

Effects Unfortunately, incentives have been associated with little in the way of strategic evaluation (McCormick and Neij, 2009). A survey of householder perceptions of instrument effectiveness conducted by Nair et al. (2011) found that subsidies and tax deductions were considered most effective. These were followed by energy labelling of products and the energy tax. Meanwhile, only 23% of respondents considered the CO_2 tax as effective (ibid, p. 7–472). While energy end users may not consider the CO_2 tax effective, in wider policy terms it is considered positively as having contributed to more efficient use of energy and having influenced the choice of heating systems (cited in Mc-Cormick and Neij, 2009) particularly the increased use of biomass in district heating systems (Johansson, 2000).

An interesting effect of economic tools is the synergetic effect, 'where two instruments enhance each other's effects' (Gunningham et al., 1998, p. 16). Subsidies for conversion of energy supply and the CO_2 tax have created such synergy. Between 2006 and 2010 householders with resistance heaters were eligible for an incentive to install water filled radiators if they concomitantly converted to district heating or installed a heat pump or equipment covering 70% of the heat demand using biomass as a fuel (Joelsson and Gustavsson, 2008). Further leverage was the CO_2 tax with its rate directly related to carbon content of fuel and with an exemption for biomass.

Another synergetic effect is observable with subsidies and technological procurement. Improving the commercialisation of newly developed energy efficient technologies has formed an important facet of Swedish energy policy since the 1990s (Högberg, 2007; McCormick and Neij, 2009). The Swedish Energy Agency sets up partnering deals with buyer groups to promote design innovation in energy performance technologies. Heating and control systems, domestic hot water systems, ventilation and energy efficient windows have been particular areas of attention (McCormick and Neij, 2009). Procurement policy is a key factor for Sweden having one of the world's most mature heat pump markets and for the development of highly efficient windows (Kiss and Neij, 2011). Kiss and Neij (2011, p. 9) note that best available technology for windows

improved from 1.8 W/m² K in the 1970s to 0.7–0.6 W/m² K in 2010 while in the same period the market share of energy efficient windows increased from 20% in 1970 (average U value of 2.0 W/m² K) to 80–85% in 2010 (average U value of 1.3–1.2 W/m² K). The authors see several instruments as important to diffusion including economic and information tools (ibid).

§ 6.3.3.3 Local energy advisors

Overview Energy policy in Sweden reflects a 'long tradition of mass schooling' and 'a strong belief in information campaigns and the ability to change through learning (cited in Löfström and Palm, 2008). 'The measures to increase energy efficiency are focused on policy instruments that support the efficiency that occurs spontaneously in society and that are adjusted to market mechanisms, especially actions to spread information and knowledge' (Högberg, 2007, p. 6). Among the longest running information instruments is national support for Local Energy Advisors (LEAs).

Central government has funded municipal energy advisors since the 1970s (with a hiatus between 1986 and 1998) (Mahapatra et al., 2011, p. 1). Municipalities have the option of requesting state support for the employment of an advisor and all 290 municipalities avail of this (SOU, 2011). Owners of single-family dwellings form the main target group (cited in ibid). The aim is to disseminate objective information concerning environmentally friendly energy supply and more efficient energy use to the public. Commonly, LEAs support other tools, namely by providing information on economic incentives.

Effects Reportedly municipal energy advisors reach approximately 200,000 individuals a year. With a population of approximately 9.2 million (Hamilton et al., 2010, p. 103), this translates to just over 2 % of the population seeking energy advice annually. Reportedly the programme is weakened by the low use (McCormick and Neij, 2009; Mahapatra et al., 2011). In a survey on effectiveness from an end user's point of view, 30% stated that LEAs encouraged them to adopt energy efficiency measures (Nair et al., 2011). Two separate research projects show that 50 and 35% of respondents were aware of LEAs (cited in Mahapatra et al., 2011).

On a positive side, the instrument is considered to function as a positive complement to other instruments (ibid). Research by Palm (2010) found that energy advisors represented a good way to reach households but recommended that a more active and differentiated approach to targeting households should be developed. Furthermore, Palm (2010) found that homeowners frequently contacted LEAs to receive confirmation that their decision was correct in terms of energy performance works. Information on subsidies is another frequently stated reason for contact (Mahapatra et al., 2011).

§ 6.3.3.4 Assessment concepts

The *combined instrument concept* is recorded as 'strong' for Sweden. The promotion of energy efficiency technology, the provisions of subsidies for over three decades (which of late focus on more sustainable energy supply through district heating, solar heating systems and/or heat pumps), taxes and information provision suggests a careful and positive mix of policy instruments. This instrument mix has also benefitted from a strong starting position: a long history of stringent building regulations (with among the world's highest standards for insulation components) and a low carbon energy portfolio (with electricity from nuclear and hydropower forming the highest percentage for space heating) (Hamilton et al., 2010, p. 104).

Instrument mixes, in the past at least, have not necessarily balanced between *obligating/incentivising* but more aptly between dis-incentivising/incentivising. This is most evident during energy supply conversion efforts with subsidies for renewable based heating supply and taxes based on carbon content. Though not strictly obligating/incentivising, the mechanism behind this concept is in evidence and is therefore plotted as 'moderate to strong' in Fig. 6.1.

Dominant instruments have operated over long time frames, for instance, the Local Energy Advisor scheme and subsidies for energy saving began in the 1970s and have operated almost consistently since that time. Meanwhile, procurement of energy efficient technologies and taxes were introduced in the 1990s. Some criticism surrounds the 'stop start' nature of subsidies and the underlying goals of subsidies being focused on assisting the construction industry rather than fuelling a strong and focused energy policy. Less clear is what future instruments will resemble especially those charged with reaching 2050 targets. According to expert interviewees building regulations during renovation will likely play a much more important role in the future. As a result of uncertainty in the future framework, the *long-term* concept is plotted as 'moderate' in Fig. 6.1.

Policy documentation states that the aim of policy instruments is to harness naturally occurring efforts to improve energy efficiency. This suggests that the *target group is undifferentiated*. According to a national expert, the split incentive is recognised as an issue but the private rental sector is not targeted in a unique way with national instruments. Similar to some other front-runners, fuel poverty is not considered an issue in Sweden; therefore, according to a national expert, designing instruments to reach lower-income households is not a policy consideration. As most economic instruments focus on reducing cost price (by 30%) or issuing tax credits, it could be assumed that lower-income householders are less likely to participate (see Stern et al., 1986). The concept of target group differentiation is plotted as 'moderate' because sub-groups such as lower-income households are considered less in need of policy attention due to social equity considerations but reaching the private rental sector remains an issue.

Economic incentives in the 1980s and 1990s focused on improving the thermal envelope giving *primacy to energy efficiency*. Moreover, the benefits of early and strict building regulations are reflected in the existing stock. With average consumption per floor area for heating, hot water and electrical appliances at 146 kWh/m² in 1990–1995 Sweden reached a level over a decade ago that other European countries are still striving towards (OECD/IEA, 2008). However, commentators mention stagnation of energy efficiency policy since the 1990s (Nässén and Holmberg, 2005). More recent instruments demonstrate a strong focus on supply side energy policy. According to a national expert, the subsidy for solar heating active in 2011 did not depend on the energy efficiency of the property. Moreover, a recent study reported that only 15% of all cost-efficient measures in the building sector are likely to be carried out (Persson et al., 2009, p. 75). Similarly, a national expert stated that primacy to energy efficiency is high on the agenda but is lost in implementation. Given the strong baseline position in terms of energy efficiency, but the apparent current lopsided focus on supply, primacy to energy efficiency is plotted as 'moderate'.

Based on similar reasoning as with the primacy to energy efficiency concept, attention to the *whole house* concept is plotted as 'moderate'. A national expert reported that while 2020 targets for energy efficiency are on track, achievements are pushing 2050 targets further away as householders are carrying out the easier measures making deeper retrofit less cost-effective. Despite this, there is evidence that major property purchaser groups in Sweden have developed renovation concepts based on the whole house approach. While they remain voluntary, according to a national expert, they are said to represent a large group. According to national experts, improving the detail and focus of evaluation efforts is considered necessary and as a result *energy sufficiency* is plotted as 'moderate'.

§ 6.3.4 UK

§ 6.3.4.1 Policy background

The UK has one of the strongest policy backgrounds of the studied cases with the Climate Change Act issuing a statutory obligation to reduce CO_2 emissions by 80% by 2050 on 1990 levels (Ofgem, 2011, p. 2). Alongside this is a statutory obligation to eradicate fuel poverty by 2016 (HCCLGC, 2008, p. 16). Challenges associated with improving existing dwellings are heavily publicised. Over 40% of the stock contains 'hard to treat' features such as solid wall construction (BRE, 2008, p. 1). Furthermore, fuel poverty affects approximately 2.4 million households (HCCLGC, 2008, p. 16).

Some unique instruments poised to enter the policy landscape answer the need for innovative policy responses. The 'Green Deal', an innovative financing 'pay as you save' arrangement attached to properties instead of owners/occupants, is due in 2012. A proposed Renewable Heat Incentive, to be introduced alongside the Green Deal, will be the first feed-in-tariff system supporting heat generation in Europe (DECC, 2010a). The Energy Act 2011 contains provisions that will make it unlawful to privately rent out properties below an EPC rating of E (DECC, 2011).

Current action towards energy saving in existing dwellings is the much applauded Supplier Obligation (SO)—the Carbon Emissions Reduction Target (CERT) (Höhne et al., 2009). This is a legal obligation on electricity and gas suppliers to achieve carbon emissions reduction targets in the household sector (Ofgem, 2011). In its current phase, CERT operates from 2008 to 2012 with expected lifetime CO_2 emissions reduction of 293Mt (ibid, p.1).

§ 6.3.4.2 CERT

Content CERT has operated in the UK since 1994 and applies to household gas and electricity suppliers with 250,000 plus customers (DECC, 2009; Rosenow, 2012). Suppliers receive a carbon reduction target based on their customer base. A predetermined carbon score is attached to energy performance measures approximately 40% of which must be achieved in priority groups such as low income households (DECC, 2010b). Under a separate obligation—the Community Energy Saving Programme (CESP)—suppliers must meet specific targets in defined low-income areas and adopt a whole house approach in meeting these targets (ibid). The enforcement body, Ofgem, has powers to penalise energy suppliers for non-compliance (Ofgem, 2011). The cost of CERT is funded through increases in customer bills (DECC, 2010b).

Effect CERT is viewed extensively as a success in terms of suppliers achieving their set targets and societal cost benefits (Ofgem, 2011; Lees, 2008). Suppliers spent approximately €2 billion as part of CERT from 2002 to 2008 (Rosenow, 2011, p. 266). Meanwhile, DECC (2010a, p. 6) state that over 7.5 million dwellings have been subject to full or part subsidy measures giving an annual saving of £45 on household energy bills. During the 2005–2008, phase costs to consumers amounted to approximately £7 per fuel per year and £5 for low income groups (DECC 2009, p. 7). In terms of the fuel poverty objective, Lees (2008, p. 5) notes that in the 2005–2008 cycle, over 1.1 million low income households were assisted with fuel switching and insulation.

However, CERT is not without its criticisms; a repeated one is the focus on 'low hanging fruit' (HCCLGC, 2008). Negative media attention highlighted mass unsolicited mail

outs of light bulbs with lighting accounting for over 25% of carbon considered saved by CERT's third year (Ofgem 2011, p. 1). Independent evaluations have proposed that the whole house approach be adopted and critique the 'lost opportunities' in dwellings receiving 'some' improvement (Lees, 2008).

Whether CERT reaches across tenure groups is another point for attention with acceptance that the private rental sector and hard to treat dwellings are unlikely to benefit (DECC, 2010a). Reinforcing this is that the private rented sector comprises the greatest proportion of hard-to-treat dwellings at 50% (BRE, 2008, p. 1). Parag and Darby (2009) view an issue with CERT to be the passivity introduced to householders, arguing that they are not motivated in psychological, social or economic ways to reduce energy demand.

While the SO has won praise for the integration of social objectives, with 40% of measures targeted to priority groups, this also forms a source of contention. It is argued that all households contribute through bill increases but not all receive measures, as a result, higher-income households receiving measures are receiving subsidies from lower-income groups if they too are not receiving measures (OECD/IEA, 2008). Some energy suppliers claim that if the primary aim of CERT is carbon reduction, then allocating a disproportionate amount of resources to lower-income groups—the lowest energy consumers—is counter intuitive (cited in HCCLGC, 2008). The argument from these dissenting voices is that fuel poverty is better tackled through direct policies (OECD/IEA, 2008).

§ 6.3.4.3 Assessment concepts

Multiple and innovative tools are in place or poised to tackle existing dwellings, but as yet they do not form a strategic combination. Therefore, the *combined instrument* concept is plotted as 'moderate'. The *obligating/incentivising* concept is considered 'weak' considering that householders are entirely incentivised to carry out energy-saving measures. CERT shows the strength of a *long-term approach* with short-term cycles for targets with the result that improvements and adjustments are made and certainty is offered to stakeholders. As a result, this concept is plotted as 'strong'.

CERT and its preceding versions have deliberately differentiated attention with a special focus on vulnerable households such as lower-income groups and pensioners. It is acknowledged that CERT fails to reach the private rental sector. This group will be targeted through the Green Deal and in the future through legislation making it unlawful to rent out EPC rated properties lower than E. Given that CERT does much for sub-groups but does not completely *differentiate the target group*, this concept is plotted as 'moderate to strong' in Fig. 6.1.

Although, at macro policy level, energy efficiency and renewable energy policy in the UK is often criticised for poor integration (Warren et al., 2011), at the level of CERT *primacy to energy efficiency* is considered 'strong'. This concept was incidentally supported by the plucking of low hanging fruit, and the importance of improving energy efficiency is apparent with the recent amendment to CERT which requires that 68% of investment be dedicated to insulation (DECC 2010b). Moreover, it is reported by a national expert that micro-generation measures performed under CERT are only approved if they are conducted in a dwelling that is efficiently insulated. Meanwhile, increasing attention to the notion of *whole house* retrofit is evident in CESP, which obliges energy suppliers to meet targets in low-income areas using this approach. Nonetheless, it is not yet the status quo and is therefore plotted as 'moderate'.

Energy sufficiency is considered 'moderate to strong' as according to a national expert while actual energy savings after implementation of energy saving measures are not measured, savings are calculated theoretically when suppliers have closed the scheme. Moreover, progress is tracked with regular publications and evaluations (Ofgem, 2011).

§ 6.4 Effective for reaching energy savings in existing dwellings?

A research objective was to identify and characterise the instruments that are considered to dominate policy action for existing dwellings in Denmark, Germany, the UK and Sweden. It emerged that the instruments dominating the action of front-runners differ remarkably. The German approach is characterised as mainly subsidising but at a highly ambitious level, the Danish approach with making tough demands at natural moments like renovation, the Swedish approach with subsidising and taxing with a long-term view of converting energy supply towards renewable sources and the UK approach with obligating energy suppliers and using their 'outreach' capacity to reach energy end users. While this makes comparing the effectiveness and efficiency of the different approaches difficult, it provides rich data into how the various energy policy and policy instrument concepts are managed.

Countries studied here demonstrate why they are at the forefront of policy action for existing dwellings in Europe. Denmark and Sweden offer glimpses of a future of fossil free energy use in existing dwelling, with Denmark initiating a phase out of oil boilers in this decade and with consistent efforts in Sweden to convert to renewable energy supply sources. The main aim of German federal level incentives is to bring existing dwellings in line with or beyond new build standards. Meanwhile, the UK set their policy commitments as legal obligations giving the issue of energy saving in existing dwelling a permanent place on the agenda.

A second objective was to identify whether and how energy policy and instrument design concepts are reflected in instruments. Analysis of front-runners confirms that they have been embedding existing dwellings in long-term policy frameworks for some time. Some of the most prevalent instruments discussed here—the EPC in Denmark, KfW incentives in Germany, taxes and procurement in Sweden and Supplier Obligations in the UK-were introduced in some form in the 1990s. With some exceptions, there is certainty that instruments, as they exist now, will persist in similar form into the future.

However, a long-term framework alone is not enough to embed energy efficiency to the extent aimed for. All front-runners report complexities with achieving ample ambition in energy saving and high participation from households. Achieving a balance between ambition and participation proves elusive with the UK achieving high participation but with criticisms of prolific distribution of low-level single measures like efficient light bulbs. Meanwhile, the German approach is the opposite, achieving less participation but high ambition. Interestingly, the German and UK approaches are said to achieve similar energy savings although at higher cost for the German approach (Rosenow, 2011).

Front-runners also show vulnerability to some of the more complex aspects of developing instruments in this policy domain. One of these is how the diverse groups that form the denizens of existing dwellings are reached. The UK comes to the fore with an obligatory focus on lower income households and proposals to 'remove' the worse rated private rental dwellings in the future if 'softer' measures fail. However, other front-runners are more silent on this front, which, inter alia, questions the equitability of instruments such as government subsidies.

Infusing the core instrument approaches with a whole house perspective and integrating energy efficiency and renewable energy ambitions remain as challenges for all front-runners. The German approach, with support for single measures as an alternative to an ambitious retrofit, shows understanding that the latter is not always possible or profitable. Similarly, in Denmark, the ideal of whole house retrofit is supported but the difficult reality of integrating this into instruments accepted. Meanwhile, primacy to energy efficiency is fused with the dominant approaches of the UK and Denmark but falters with German and Sweden cases.

A recurring theme is that little is known about the direct and indirect effects of many instruments. Few instruments are designed alongside monitoring and evaluation programmes that can link them to effects. Instead, implementation of the instrument alone is often considered sufficient. A pertinent example in this regard is the introduction of the EPC throughout Europe, mirroring the Danish instrument. At its introduction, the EPC in Denmark was an innovative instrument with a logical theory of closing the information gap on the energy efficiency of properties during transaction.

Yet evidence of the effectiveness of the instrument in Denmark had not been amassed when it entered into the European legislation. Now that evidence has been gathered, its strength, at creating a more informed and discerning buyers/renters' market, is questionable. The persistent failure to track instruments hinders an understanding of instruments most suited to this policy domain.

§ 6.5 Conclusions

The aim of this study was to explore evidence-based examples of effective instruments designed to improve energy performance in existing dwellings. Front-runners were identified as a source of learning. Only the instruments that are considered to dominate policy action were analysed. As well as searching for effectiveness in terms of reported reduction of CO_2 emissions, this study sought to identify how instruments overcome barriers and exploit opportunities by assessing them according to a number of prominent concepts from energy policy and policy instrument literature.

Ambitious climate change targets mean that policy action must excel across a range of policy instruments. The instruments that lead action in front-runners cover a range from which some lessons can be drawn. Lessons include using performance-based incentives to push the boundaries of ambition (Germany), the creative use of instrument combinations to steer towards ambitious targets or alternative energy sources (Sweden), the use of stakeholders that can reach the target group en masse (UK) and the role of regulations whether defining standards or eliminating fossil fuel-based technologies (UK and Denmark).

However, even the instruments that rate among Europe's most ambitious are not considered adequate by many commentators, either because they are not intensive enough or because the complementary instruments are undeveloped. Instruments struggle to integrate concepts like 'primacy to energy efficiency' and 'whole house', which could be expected as commonplace in response to climate change targets. A combination of tougher obligations, stronger incentives and more creative use of instruments appear as prerequisites if existing dwellings are to play their assigned role in climate change policy. A crucial and related lesson revolves around confidence in information about progress to climate change targets. Even some of Europe's front-runners have yet to develop adequate monitoring and evaluation programs that prove and link their instruments with impact.

An interesting avenue for further research would be a collaborative study with several front-runners to study in depth how instrument packages operate. Alongside this, deeper understanding of dwelling owner/occupants and the role of instruments in their decision making could fill research gaps. An additional research avenue could be cross policy comparative learning to identify ways in which challenges such as balancing participation with ambition have been managed in other sectors.

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7 Conclusions and recommendations

§ 7.1 Introduction

The 2015 Paris Agreement resulting from the United Nations Climate Change Conference (COP21) signifies consensus to limit global warming to less than 2°C compared to pre-industrial levels (Carrington, 2016). This agreement is the culmination of decades of climate change policy negotiation at global level. As with agreements that have gone before, to become a reality, progress at reducing energy use is required across levels and sectors.

As the largest energy consuming sector, the building sector is vital to meeting energy saving and climate change targets. The future of new buildings in Europe is energy neutrality. Yet any energy use revolution in the housing sector rests with existing dwellings. It is these dwellings constructed during times of absent or less ambitious building regulations that make up the massive bulk of the housing stock. A huge percentage of the overall housing stock is considered 'leaky' with dazzling statistics of the quantity that requires energy retrofit if targets are to be met, 300,000 annually in the Netherlands to meet 2020 targets (Vringer, 2014, p. 9). Longer range ambition is that the average Energy Performance Certificates (EPC) rating of dwellings is an A by 2030 and that all dwellings are energy neutral by 2050 (ibid).

Despite many of the same instruments operating for decades there is a lack of empirical data on whether and how instruments materialise into energy savings in existing dwellings. Understanding of 'old' instruments like energy audits and taxes and 'newer' instruments like EPCs and performance based subsidies and whether and how they operate in a combined strategy is unsophisticated. Even among countries regarded as front-runners, targets for energy saving in existing dwellings fall short. It is the aim of this research project to advance knowledge about how current instruments function and to explore the type of instruments that can hope to lever the existing housing stock towards targets.

The main research question of this thesis looked at aspiration compared to reality asking if national policy instruments matched policy ambition to improve energy performance in the existing housing stock of the Netherlands. The theoretical ambitions of policy instruments and the practical realities of their implementation were explored through a number of avenues to deepen understanding and insight.

The perspectives of experts were gathered from the Netherlands and from front-runner countries and analysed in combination with available official and academic evaluations. Assessment frameworks were developed to delve deep into the mechanisms and impact of instruments with the aim of going beyond a simplistic examination of strengths and weaknesses to one that looked at whether the ideals of instruments in this domain were reached. The perspectives and experiences of owner occupiers who adopted energy saving measures were analysed. Equally, the perspectives of owner occupiers who did not adopt energy saving measures were analysed. The main research questions per chapter are revisited below followed by limitations and advantages of data, implications for theories and concepts and recommendations for further research.

§ 7.2 Understanding and insight

§ 7.2.1 Are national policy instruments sufficient to meet energy performance targets?

The first step towards meeting the aim of research was to assess and characterise national instruments in the Netherlands. In the absence of an assessment framework for policy instruments in this domain one was created using elements of the theory based evaluation method and familiar concepts in this field. Official and academic evaluations and stakeholder interviews were used as the data sources. This approach was very useful at delving deep into the different dimensions of instruments beyond a review of strengths and weaknesses.

The question guiding this research component was: are instruments, according to experts and published sources, sufficient to meet energy performance targets? The conclusion is that instruments are insufficient for a number of reasons:

Fundamental problems were identified with how instruments are implemented. Most notable at the time of expert interviews was how the EPC was implemented without an enforcement regime resulting in poor visibility, confusion and lack of confidence in the market distancing the EPC from its original ambitious theory and objective. Similarly, the Meer met Minder sectoral agreement was associated with financial issues and lack of clarity on responsibilities between parties. Economic incentives were heavily criticised by expert interviewees and found wanting from evaluations being described as 'modest' and 'highly fragmented'. Meanwhile, the energy tax was

unanimously described as revenue raising with minimal impact on behaviour change. Little could be gleaned from published sources or expert interviewees on the impact of information tools although some interviewees believed that tools are designed for the already informed. Building regulations were found to lack the innovative dimensions visible from other countries, such as consequential works, though few interviewees saw potential to strengthen this instrument.

Moving from the micro level of how instruments functioned on the ground to the macro level of how they compared to normative concepts showed that the theory of what this policy landscape should look like remains very different from the reality. Elements of some concepts were present but were far from pervasive. Instruments were:

- Typically stand alone instead of being combined
- Largely short term instead of being embedded in a long term framework
- Almost entirely incentivising thus lacking the obligating balance suggested from theory
- Generic thus ignoring the great diversity associated with households
- Piecemeal in place of whole house
- Disassociated from an end point of energy use reduction.

The Meer met Minder subsidy was the only performance based subsidy in place at the time of research and was highly regarded by interviewees. With subsidy amounts linked to rating changes in the energy audit it also demonstrates a successful coupling of instruments. Interviewees though regretful of how the EPC had been progressing remained hopeful for a better future for this instrument with scope for different manipulations for example, with links to property taxes.

§ 7.2.2 Do energy performance policy instruments work on owner-occupiers?

It became evident during research for chapter 2 that many of the perceived successes and failures of instruments were anecdotal. Expert interviewees directly involved in instrument development and implementation confirmed that what little evaluation takes place is at a user satisfaction level and not related to the extent to which the original objectives of instruments are met. The aim of chapter 3 was to overcome this and search for associations between instruments and the adoption of energy performance measures. Contextual aspects of householders and dwellings were also examined. The main research question was: are energy performance policy instruments associated with the adoption of energy efficiency measures?

The conclusion was that instruments are largely associated with the adoption of energy saving measures. Exceptions were the EPC, energy tax and energy saving loans.

Analysis could not be conducted on energy saving loans due to poor take up among respondents which is nevertheless considered an important finding. Contact with national organisations emerged as the strongest instrument with 60% of respondents describing this as an influence in energy efficiency investment. An exception however was contact with Energy Companies. Energy audits were not associated with deep retrofit, one of the main objectives of this tool. Confirming the results found in chapter 2, the Meer met Minder subsidy performed well with 57% of recipients who found it an influence stating that they would not have carried out measures without it while 49% of respondents carried out more measures because of it.

While close to 60% of respondents deemed information and economic instruments as influential it is not an overwhelming result and far from the transformative policy response one could expect given ambitious national climate change targets. What is more, the results of an entirely soft law approach were evidenced with the main reason for not carrying out energy saving measures being an understanding of adequate dwelling energy efficiency. Furthermore, high energy users emerged as less likely to adopt energy performance measures. Such results support arguments for an obligating/incentivising balance in the instrument approach.

Results were largely in keeping with other research in this area. Householder age and size were significant for energy retrofitting but income, education and occupation were not. Energy saving measures were associated more with detached dwellings than apartments and terraced dwellings as well as with older dwellings.

§ 7.2.3 What is the role of energy audits in energy efficiency investment?

The energy audit is one the longest standing tools in the policy instrument repertoire for existing dwellings. The theoretical assumption is that this tool removes the barrier of inadequate information by providing what is considered one of the best types of information, customised to a dwelling and face to face with the owner occupier. However, there is little empirical evidence that audits function as intended. Chapter 4 was concerned with the research question: do energy audits influence owner occupiers in the adoption of energy efficiency measures?

A minority of respondents, 19%, stated that the audit rating or recommendations influenced them in the adoption of energy performance measures. The main influence of audits was that they confirmed information already held by householders. When analysed statistically no significant association was found between having an audit and carrying out energy efficiency measures. Audit recipients were more likely to have installed 1 to 2 measures while non-recipients were more likely to have installed 4-9

measures. Furthermore, non-recipients spent more on energy efficiency measures and planned on taking more measures in the future.

Results also highlighted the complexities of linking instruments to householders and of the barrier approach. A significant portion of audit recommendations were neither adopted nor planned. Furthermore, a significant portion of recommendations were adopted or planned that were not recommended! What is more, the main reason that respondents gave for not adopting measures was that they considered their dwellings to be adequately energy efficient. This was despite living in dwellings that would fall within the national policy radar of dwellings that could be improved for energy performance.

§ 7.2.4 What is the role of the Energy Performance Certificate (EPC) in energy efficiency investment

One of the newest policy instruments and one filled with great promise at its inception was the EPC. At the time of the survey the lack of an enforcement regime in the Netherlands provided an ideal test environment to compare householders who bought their dwelling with an EPC compared to those who bought it without. The research question was: what is the influence of the EPC? Influence was examined both pre and post-purchase. Pre-purchase in terms of whether the EPC influenced price negotiation and post-purchase in terms of whether the EPC recommendations influenced the adoption of energy saving measures.

The EPC was found to have a weak influence. Only 10% of the EPC sample stated that the instrument influenced the property purchase. Meanwhile, 22% stated that the EPC influenced the adoption of energy performance measures post-purchase. Neither was a statistical significance found for having an EPC and adopting energy saving measures. EPC recipients were found to be more likely to invest in future energy efficiency measures. However, the EPC sample were more likely to live in older dwellings which could also explain this finding. A difference between measures adopted was identified with EPC recipients more likely to have adopted wall insulation and renewable technologies.

The implementation issues and lack of confidence which expert interviewees mentioned during research for chapter 2 emerged during this research component. Over 30% of respondents had requested an EPC but did not receive it. Over half of non-recipients did not request an EPC because they did not consider it necessary.

When EPCs did manage to move through the maze of implementation issues and disinterest some positive influences emerged. In this regard, 36% of the EPC sample stated that they would use their EPC as a guide for energy performance improvement.

As with previous research components the nuances of householder decision and non-decision making emerged. For example, while potential buyers were unlikely to negotiate on the basis of an EPC rating or energy efficiency a significant portion appear to appreciate that energy efficiency offers value to a property. Similar to the energy audit it is concluded that the EPC is not taken at face value, 50% of recommendations were ignored and a large number of measures were adopted or planned but not recommended.

§ 7.2.5 Are the policy instruments of European front-runners effective?

A theme running throughout this thesis is the lack of understanding about the type of instruments best suited to meet the ambitious targets for existing dwellings. In this chapter, the instruments that formed the main policy response to improve energy efficiency in existing dwellings in countries considered as front-runners were assessed. An aim was to go beyond an understanding of effectiveness based on expected reductions in CO_2 emissions based on instrument take up to one which delved into the characteristics of instruments and the extent to which they met key challenges in this policy domain. An assessment framework was developed, mirroring that used in chapter two, with a number of 'ideal concepts' from which to judge effectiveness. The central research question was 'how effective are the policy instruments of European front-runners for driving energy performance improvement in existing dwellings'?

The instruments that dominate action among the study cases were remarkably different. The German approach was characterised as mainly subsidizing but at a highly ambitious level, the Danish approach with making regulatory demands at natural moments like renovation, the Swedish approach with creatively combining subsidies and taxes with a long term view of converting energy supply towards renewable sources and the UK approach with obligating energy suppliers and using their 'outreach' capacity to reach energy end users.

Characterising instruments in terms of content and effect found that while the instruments that dominate action in the chosen cases display some very innovative and effective elements all approaches struggled with achieving adequate levels of ambition for energy retrofit and high levels of participation. Assessing instruments according to criteria developed for this research component showed that no front-runner met all the ideals of policy in this arena. With the exception of the UK approach questions

of equitability surround instruments especially subsidies which appear to be more attractive to the well off. Front-runners were generally operating their instruments and programs for existing dwellings over a long period while they were moderate to strong in primacy to energy efficiency in instrument development. Infusing the core instrument approaches with a whole house perspective was achieved strongly only by Germany. Sweden and Germany excelled at using instruments creatively in combination. The obligation/incentive balance did not appear strongly in the core instrument of any front-runner. A similar result was found for instruments which integrate energy sufficiency. In this case, the UK approach fared best being the only example of where routine monitoring of the main instrument, supplier obligation, was carried out to identify whether energy use could be considered to be reducing.

§ 7.3 Overall conclusion

The conclusion to this research is that national policy instruments do not match ambitions to improve energy performance in the existing housing sector in the Netherlands. A number of instruments were found to deviate from their intended impact. A large portion of recommendations from energy audits and EPCs were ignored and a significant number of measures were adopted that were not recommended. The EPC, energy tax and energy saving loans were not associated with the adoption of energy saving measures. Approximately 40% of survey respondents who used instruments did not consider them an influence. With the exception of the Meer met Minder subsidy instruments were not combined to maximize individual strengths and offset weaknesses. There is no evidence of an obligating/incentivising balance and instruments were not clearly embedded in a long-term framework. Moreover, there is virtually no feedback on the impact of instruments in terms of actual energy consumption reduction. Such results were found far removed from the ambitious targets expounded from policy documentation.

§ 7.4 Contribution to science

This research offers unique scope and depth to the examination of instruments for improving energy performance of existing dwellings. The complete range of national policy instruments available to owner occupiers in the Netherlands were comprehensively assessed many of which had never undergone previous evaluation.

A deep analysis into the impact and influence of instruments using a triangulation of methods was carried out. Experts involved in the design and implementation of instruments, official and academic evaluations and reviews of instruments and householder experiences of instruments were brought together to provide understanding and insight into the 'on the ground' efforts to meet climate change targets. In so doing an under researched area was explored and pertinent questions into the actual influence of instruments singly and in combination were posed. Insight into the inner workings of instruments found that many instruments fail to achieve what they set out to do in theory.

Implementation issues with the EPC in the Netherlands at the time of research allowed for a comprehensive assessment into this instrument allowing for a control group to be compared to a recipient group. This approach allowed for unique insight into the workings of the EPC finding its impact to be negligible.

A unique assessment framework was developed for components of this research (chapters 2 and 6). Using concepts from literature and the policy arena meant that instruments could be placed under an assessment lens focusing purely on attributes related to energy efficiency instead of a more general and typical study into strengths and weaknesses.

§ 7.5 Limitations and gains

An aim of research presented in this thesis was to offer qualified accounts of how instruments for energy performance improvement in existing dwellings work. Research components focused on both individual instruments and complete strategies using a triangulation of methods and sources: expert interviewees, a survey and literature review. Each research method and approach offered its own limitations and gains. Expert interviews were used for chapters 2 and 6. For the research component in chapter 2 semi-structured face to face interviews were conducted with 19 experts. Interviewees were selected to present an overall view of the topic while belonging to sufficiently different organisations (Rubin and Rubin, 2004). To avoid bias, results from interviews were only included if they converged across a number of interviewees from sufficiently different affiliations. However, Wilson et al. (2015: 19) note that "the understanding shared by policymakers and practitioners of how energy efficiency can and should be improved is deeply institutionalized". This was recognized during expert interviews and found to limit the inquiry into the possibilities of instruments. However, a gain of this research method was that the many evaluation gaps that exist could be filled using the knowledge and experience of experts directly involved with

instruments. Furthermore, to reduce any compartmentalised thinking about policy instruments in chapters 2 and 6 frameworks were developed to assess instruments against policy ideals instead of a narrower focus on strengths and weaknesses.

Six expert interviewees were interviewed for the research component in chapter 6. Interviews were conducted over the telephone due to locational factors. As opposed to face to face interviews such interview types cannot avail of social cues. The low number of interviewees could be considered a limiting factor as saturation point was not reached. Nonetheless, the aim of expert interviews in this case was to confirm and go beyond official and academic evaluative research which was achieved.

Chapters 3-5 relied on findings from a large survey. A limitation of surveys in this domain is that respondents are likely to be more engaged about the topic than the average population. Furthermore, survey participants generally have higher income and education levels than the average (Hirst et al., 1981; Wirtshafter, 1985, Stern et al., 1986, Stieβ et al., 2010) a finding which received further confirmation in this survey. While it brings disadvantages it nonetheless allowed strong inferences to be made about the 'able to buy' population using instruments and adopting energy saving measures and 'control' groups of respondents not using instruments or adopting energy saving measures.

The survey was only presented online. This was for reasons of cost effectiveness and for formatting reasons (the survey was designed to capture a number of sample groups and an online survey allowed respondents to seamlessly follow to their next applicable questions, on paper this would have been very difficult for respondents). Nonetheless, it is recognized that groups without access to the internet were unfortunately excluded.

§ 7.6 Theories and concepts

Research presented here shows the need for a much deeper understanding of owner occupiers and the role of instruments in their decision making. Results presented in this thesis and elsewhere demonstrate the need for a richer model that goes beyond the current barrier and market transformation models for developing instruments. Instead, owner occupiers and their investment decisions are incredibly nuanced surpassing the simplicity of current approaches. This research identified serious issues with the type and level of information that seeks to remove the 'information barrier'. Furthermore, an overemphasis of financial costs and savings appears to negatively influence the formation and impact of instruments. Specifically in this research, householders were found to:

- Ignore the bulk of recommendations offered to them in customised audits even when audits were requested
- Often carry out measures not recommended to them
- Commonly observe the value of energy efficient dwellings but not enough to adopt energy efficiency measures
- Be largely unaware that they pay tax on their energy use
- Be frequently unaware if they pay lower energy bills after adopting energy saving measures even if saving money was a motivating factor for adopting measures.

Research found a deeply entrenched yet unsophisticated manner of conceptualizing policy instruments and owner occupiers. At a basic level, gaps in understanding exist on how instruments are implemented and their impact. At a more complex level, gaps in understanding exist on how instruments can balance competing demands on their performance, notably achieving ambition in energy retrofit and widespread public appeal. Further gaps exist in understanding how the ideals of policy instruments can be truly met such as how instruments can be effectively combined and how energy use can be actually reduced with instruments. More sophisticated theorizing about the instruments that can actually bring the ambitions of global climate change agreements to a reality, with certainty, is a fundamental requirement if existing dwellings are to contribute effectively to meeting targets in the Netherlands and elsewhere.

Results from the survey conducted for this research found that many householders who used instruments are willing to share their experiences. Many survey respondents agreed to be contacted again for this research. Such opportunities to truly understand householders and their motivations and experiences are needed to advance knowledge about householders and instruments.

§ 7.7 Recommendations

In terms of both process and impact there is tremendous scope for learning about policy instruments. A collaborative study with several front-runners to study in depth how instrument packages operate is one avenue to advance this. Cross policy comparative learning to identify ways in which challenges such as balancing participation and ambition and combining instruments effectively have been managed in other sectors is another possible avenue for learning. Furthermore, all research components highlighted a remarkable lack of monitoring and evaluation programs that prove and link instruments with their impacts. Information about impact was mostly anecdotal which not only leads to uncertainty about instruments but denies a proper

data bank for learning and adaptation or removal of instruments. Much more attention to developing adequate monitoring and evaluation programs and to policy learning is required.

Results of this research show a tremendous gap between the ambition and determination of climate change policy at international, supranational and national level and results on the ground. Based on the findings of this research this gap is attributed to the voluntary nature of policy instruments and the responsibility of householders in determining an acceptable level of dwelling energy efficiency. It could be argued that energy audits are the cornerstone instruments of existing dwellings where building regulations are the cornerstone of new buildings. Yet research presented here shows that over 70% of audit recommendations are ignored. Survey results found that a main reason for not investing in energy efficiency measures was that householders considered their dwellings to be energy efficient. In stark contrast to policy parlance stressing urgency for 'transforming the stock', 'deep retrofitting' and 'achieving zero' action on the ground is determined by householder perception of an energy efficient dwelling with the support of often modest instruments if householders do decide to adopt measures.

Instruments are considered modest as subsidies and loans typically offer minimum financial support for single energy saving measures. At the same time such instruments are often fragmented, typically disappearing when budgets are reached. Information instruments are also considered modest with few instruments promoting deep retrofit or innovative measures and approaches. All of the above are considered strong evidence that serious investigation into the role of a minimum standard for existing dwellings is required.

Moreover, investigation into more permanent and more innovative instruments for existing dwellings is required. The study into front-runners found such elements, for example, at the time of research 40% of loans for long running 'KfW Efficiency House' in Germany were for renovations pledging to go beyond new build requirements (see Murphy, 2014c/Chapter 6). Given the ambition of targets, instruments promoting such performance based and ambitious approaches should be the norm yet they remain the strong exception rather than the general rule.

Instruments with track records of failing to achieve what they set out in theory require serious investigation, primarily the EPC and the energy tax. Ways to make these instruments mean something to householders and to trigger the changes required in energy use are essential especially as these instrument look set to remain.

That high energy users were less likely to adopt energy efficiency measures raises an additional challenge to policy instrument development. Instruments that become successful at pushing householders towards improving their dwelling fabric and

installations can only be truly meaningful if householders use energy at a sustainable level. A reworking of the energy tax system to more accurately reflect the polluter pays principle could offer a possibility to influence energy use in a positive direction. An examination into ways that instruments can lead to actual energy use reduction with certainty is needed. As a starting point monitoring the pre and post energy use of households that have used policy instruments is recommended

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Appendix 1

Scoping questions: expert interviewees in the Netherlands

1 What are your views on the current approach to tackling energy performance in the existing housing stock in terms of the policy instruments used?

2 What do you see as the impact of the energy transition?
   - Internationally the energy transition in the Netherlands attracted attention as a new policy direction: "solving the major environmental problems requires system innovation; long drawn-out transformation process comprising technological, economic, social-cultural and institutional changes" (VROM, 2001: 30).
     - Do you see evidence of an impact from the energy transition?
     - Has this approach altered the Dutch policy style and substance towards energy policy?

3 What do you see as the role of covenants like Meer met Minder, Energiebesparing Corporatiesector Covenant?
   - Theory & practice suggest that covenants can act as a testing ground for new regulation, as a complementary tool for regulation and/or as a platform for new knowledge and better stakeholder relations.
     - Do you see evidence of this in the two covenants designed to improve energy performance of the existing housing stock?

4 Despite a difficult beginning the Energielabel (Energy Performance Certificate) is now gaining a stronger mandate to deliver energy performance improvement to houses in the Netherlands, what are your views about this instrument?
   - The idea from the EC was that Energy Performance Certificates would act as communication instruments that would drive market demand for energy efficient existing housing yet empirical evidence demonstrating this causal effect is absent. In the Netherlands there are plans to alter the function somewhat e.g. by using the label as a means of setting requirements for new home owners that a certain label class is achieved within a set period.
     - What are your views about possible changes to the EPC system to make stronger demands?

5 Do you consider that there is a role for stronger building regulations for existing houses?
   - In some European countries (England & Wales-regional) building regulations can be used to make homeowners improve the energy performance of parts of

their homes not undergoing renovation or can be used to ensure that a certain percentage of energy comes from renewable sources following renovation (Germany-regional).
    - Do you see scope for this kind of strengthened regulation in the Netherlands?

6 Do you think municipalities should have more power to determine building regulations?

7 How you do think economic incentives like subsidy schemes currently function in the Netherlands?
    - Do they follow theories, for example, that this tool type should incentivise beyond minimum standards?

8 How you do think information/communication tools currently function in the Netherlands?
    - Do you consider that these tools encapsulate what we know about human behaviour?
    - Are they proven to be effective in your opinion?

9 Do you think there is a strong enough role assigned to third parties? The current focus is on incentivising/placing responsibility on the home owner. Third parties e.g. energy companies play a greater role in some other countries.
    - Could sharing responsibility with or requiring co-operation from third parties improve the policy process in the Netherlands?

10 Do you think the right perspective of energy is being promoted through the current use of policy instruments?
    - Current policy instruments represent an approach focused on operational energy use and the building envelope. Carbon associated with building materials and occupant behaviour is untouched by tools.

11 Given the urgency attached to realising climate change objectives do you see a case for establishing a limit on a household's energy use?

12 What do you think the future policy landscape will look like for existing houses in the Netherlands?

Appendix 2

QUANTIFICATION OF SAMPLE REQUIREMENTS

DATABASE I: EPC/AUDIT SAMPLE

Assumptions Section I Questionnaire

It is assumed that householders will have an EPC because:

1. They moved house;
2. Their house is for sale;
3. They had an energy audit carried out (official energy audits include an EPC).

1. EPC because householders moved

- 16,000 private dwellings sold in 2010 with an EPC (CBS 2011). 2010 database could contain EPCs from previous years (began 2008). 2010 more EPCs than previous (ECN 2010) (2010-10% dwellings sold with an EPC). Possibility that approx. 5,300 dwellings registered in database were issued with an EPC due to being sold (worst case scenario).

2. 'For sale' dwellings with EPC

- Average selling time in the Netherlands in 2010 was 19 months (http://www.moviq.nl/verkooptijd) therefore it is assumed that 8,400 dwellings in the EPC database are registered because they are 'for sale'.

3. Recipient of energy audit

- Energy audits (Maatwerkadvies) includes an EPC and are included but not differentiated from sale/purchase EPCs in the database. From July '09-Dec '10 €10mln was available in subsidies adequate for approx. 50,000 dwellings. By Jan '10 5% of the budget was utilised by 23 Nov '10 it was exhausted (MmM 2011). Subsidies are also given by local authorities.
- Database contains an estimated 60,000 registrations for private sector approx. 14,000 of which have an EPC because of the buying/selling process (Funda).
- Based on the above it is assumed that 80% of respondents will answer yes to the question "Do you have an EPC'? and 20% will state no or don't know. It is assumed that 8% will have an EPC because they moved house, 15% because they are trying to sell their house and 85% because they have an energy audit containing an EPC.

- The critical path for statistical analysis is householders who hold an EPC due to dwelling purchase (movers) the lowest positive response at 8% of 80%=.064
- 35 responses (needed for statistical analysis) at 8% response rate means that the number of questionnaires needed for successful analysis of questions in section I is 6836.

Assumptions Section II

A range of estimates are made on the percentage of dwellings that undertake energy saving measures:

1. The WoON survey (2010) stated that 20% of dwelling pre-1990 construction had undertaken insulation measures (% private dwellings not stated);
2. Monitoring as part of the building sector covenants found that 600,000 and 625,000 dwellings in 2008 and 2009 respectively undertook 1 or more energy saving measures - 9% of 7mln dwellings in the Netherlands (Survey based on 80,000 occupants);
3. As part of the IDEAL EPBD project 565 homeowners in the Netherlands were surveyed from data in the EPC database. 407 had purchased their dwelling in the four years preceding the survey. 14%, 20% and 25% had installed wall, floor and roof insulation respectively while 38% had installed energy efficient glazing (these survey respondents will have included recipients of energy audits and may be more likely to have carried out an energy saving measure). Based on the above it is assumed that 10% of respondents will have carried out an energy saving measure considered 'substantial' i.e. to positively affect energy consumed for space heating.

- Critical path: householders with EPC and who took an energy saving measure assuming 8% response rate .08 (8%response rate) x 0.8 (EPC holders total) x [.08 (EPC buyers) + .92 (energy audit) x .14 (EPC sellers)] = 0.013952/.1 (householders took a saving measure) 0.00139.
- Assuming 8% response rate the number of questionnaires to be sent out for successful statistical analysis is 26,316.

Assumptions for Section III

- With an annual renovation rate <1.5% (Itard & Meijer 2008) a low response rate is assumed.
- This question is included in the interest of completeness.
- Non-critical - general context.

Assumptions for Section IV

- As part of the IDEAL EPBD project out of a population of 565, 285 (50%) stated they would carry out an energy saving measure of which 22%, 12%, 12% & 19% respectively stated that they would install high performance windows, wall, floor and loft insulation. Based on this result it is assumed that approx. 10% of a sample of Dutch households plan on undertaking an energy saving measure.
- Critical path: is householders who are planning energy saving measure at 10%
- 35 responses at 8% response rate
- Complete questionnaires required is 350
- Assuming 8% response rate the number of questionnaires to be sent out for successful statistical analysis 4375.

Assumptions for Section V

- It is assumed that a large number of questionnaire recipients will have received a subsidy for an energy audit, approx. 60%.
- Critical path: householders who used an economic incentive at 60%
- Complete questionnaires required 58
- Assuming 8% response rate number of questionnaires to be sent out for successful statistical analysis: 725.

Assumptions for Section VI

- No information could be found on awareness and effectiveness of the energy tax from bottom up level. Based on commentary from e.g. BZK (2010) who consider the effect of the tax to be minimal it is assumed that few respondents will be aware of how much they pay while more may be aware that it is included in their energy bill. As with building regulations section VI is included for completeness.
- Non-critical - general context

Assumptions for Section VII

- With energy audit recipients excluded worst case scenario low response rate assumed.
- Critical path: householders who used an information tool at 3%
- Completed questionnaires required 1167
- Assuming 8% response rate number of questionnaires to be sent out: 14587.5

DATABASE II: CONTROL GROUP: VEH SAMPLE

Assumptions Section I

- 83% respondents will not have an EPC
- 16% respondents will have an EPC because of dwelling purchase
- Possibility of having EPC because of having an energy audit 1%
- Assumptions based on CBS 2011, Meer met Minder 2011 (number of energy audit subsidies)
- Critical path: householders who do not have an EPC 83%
- Statistical Analysis 50 responses
- Completed Questionnaires required 60
- Assuming 8% response - Number of questionnaires to be sent out: 750.

Assumptions Section II

A range of estimates are made on percentage of dwellings that undertake energy saving measures:

1. The WoON survey (2010) stated that 20% of dwelling pre-1990 construction had undertaken insulation measures (% private dwellings not stated);
2. Monitoring as part of the building sector covenants found that 600,000 and 625,000 dwellings in 2008 and 2009 respectively undertook 1 or more energy saving measures - 9% of 7mln dwellings in the Netherlands (Survey based on 80,000 occupants);
3. As part of the IDEAL EPBD project 565 homeowners in the Netherlands were surveyed from data in the EPC database. 407 had purchased their dwelling in the four years preceding the survey. 14%, 20% and 25% had installed wall, floor and roof insulation respectively while 38% had installed energy efficient glazing (these survey respondents will have included recipients of tailored advice and may be more likely to have carried out an energy saving measure). Based on the above it is assumed that 10% of respondents will have carried out an energy saving measure considered 'substantial' i.e. to positively affect energy consumed for space heating.

- Critical path: householders (without an EPC) (83%) who took an energy saving measure (10%)
- Statistical Analysis based on minimum 50 responses
- Completed Questionnaires required 602
- Assuming 8% response - Number of questionnaires to be sent out: 7530.

Assumptions for Section III

- With an annual renovation rate <1.5% (Itard & Meijer 2008) a low response rate is assumed.
- This question is included in the interest of completeness.
- Non-critical - general context.

Assumptions for Section IV

- As part of the IDEAL EPBD project out of a population of 565, 285 (50%) stated they would carry out an energy saving measure of which 22%, 12%, 12% & 19% respectively stated that they would install high performance windows, wall, floor and loft insulation. Based on this, it is assumed that approximately 10% of a sample of Dutch households plan on undertaking an energy saving measure.
- Critical path: householders planning energy saving measure (10%)
- Statistical Analysis based on 50 responses
- Completed Questionnaires required 500
- Assuming 8% response - Number of questionnaires to be sent out: 6250

Assumptions for Section V

- An assumption based on free-rider estimates is used to estimate the number of respondents who will have used an economic incentive. Estimates of free ridership range from 29-45% based on Stern et al 1986 and Meer met Minder (2010). Therefore, out of the 10% of respondents assumed to have taken an energy saving measure it is assumed, based on a lower estimate from free ridership estimates that 30% will use an economic incentive. Moreover, it is assumed that 66% of the EPC database will have used a subsidy for an energy audit.
- Critical path: householders who used an economic incentive & carried out an energy saving measure (30% x 10%)
- Statistical analysis based on 35 responses
- Completed Questionnaires required 1406
- Assuming 8% response - Number of questionnaires to be sent out: 17570

Assumptions for Section VI

- No information could be found on awareness and effective of the energy tax from bottom up level. BZK (2010) consider the effect of the tax to be minimal therefore it is assumed that few respondents will be aware of how much they pay while more may be aware that it is included in their energy bill. As with building regulations Section VI is included for completeness
- Non-critical - general context

Assumptions for Section VII

- Low response rate assumed
- Critical path: householders who used an information tool (3%)
- Statistical Analysis based on 50 responses
- Completed Questionnaires required 1667
- Number of questionnaires to be sent out: 20837.5
- for 35 responses
- Completed Questionnaires required 1167-number to be sent out:14587.5:

Appendix 3

Questionnaire (English translation)

Note: This questionnaire was only available online due to the complexity of the routing. Therefore, readability is hampered due to the fact that all questions are presented to the reader here. In reality respondents were brought on specific routes through the questionnaire depending on their answers. Due to this some questions seem like they are repeated, especially those related to the EPC/Energy audit. They were not repeated to respondents but related to their particular situation of having an EPC/Energy audit whether through house sale or purchase, because of a subsidy requirement or general interest etc.

1 This questionnaire is for homeowners:
Do you live in an owned or rented dwelling?
- ☐ Owned dwelling (Continue with questions)
- ☐ Rented dwelling (Proceed to question 2)

2 You can stop now. Thanks for your time.
You can fill in your email address here for the lottery. We will not use your email address for with objectives. My email address is:

This questionnaire is about the influence of instruments developed to help you save energy in your dwelling.

The questionnaire is divided into parts with questions about the Energy Performance Certificate (EPC) building regulations, financial and information instruments. There are also questions about energy saving measures you have carried out or that you are planning.

At the end of the questionnaire there are a number of questions about you and your dwellings. We begin with questions about the EPC.

The EPC and energy audits (tailored advice)

The EPC is sometimes available during the viewing or purchase of a dwelling. The EPC shows, with letters, the energy performance of the dwelling (A=efficient, up to and including G= not energy efficient). The EPC also contains recommendations about how you can improve the energy performance of your dwelling.

Energy audits also often contain an EPC. There are different types of audits, for example, the energy saving advice from the Association of Home Owners. An audit contains more detailed information about energy saving measures than the EPC.

3 Do you have an EPC for your dwelling? (this can also be in an energy audit)
- ☐ Yes Continue with question 4
- ☐ No Continue with question 8
- ☐ I don't know Continue with question 8

4 Did you receive an EPC when your purchased your dwelling?
- ☐ Yes Continue with question 9
- ☐ No Continue with question 5

5 Do you have an EPC for your dwelling because you had an energy audit carried out?
- ☐ Yes Continue with question 17
- ☐ No Continue with question 6

6 Do you have an EPC for your dwelling because it is for sale?
- ☐ Yes Continue with question 17
- ☐ No Continue with question 7

7 Do you have an EPC for your dwelling for another reason?
- ☐ Yes Continue with question 17
- ☐ No Continue with questions in section II ENERGY SAVING MEASURES

8 Did you buy a dwelling between 2008 to 2011?
- ☐ Yes Continue with question 11
- ☐ No Continue with questions in section II ENERGY SAVING MEASURES

9 Did you have to ask for the EPC from the seller/estate agent?
- ☐ Yes
- ☐ No, it was already available Continue with question 14

10 Why did you request an EPC? (multiple answers possible)
- ☐ I understood that it was a requirement
- ☐ I wanted to know about the energy performance of the dwelling

- ☐ I was advised by the estate agent/notary to do this
- ☐ Because of another reason, namely:

11 Did you ask the seller/estate agent for the EPC?
- ☐ Yes, but I didn't receive one
- ☐ No Continue with question 13
- ☐ I don't know Continue with question 24

12 Why did you not receive an EPC?
- ☐ I was told by the estate agent that it was not required Continue with question 24
- ☐ Another reason, namely: Continue with question 24.

13 Why did you not ask for the EPC (multiple answers possible)
- ☐ I didn't know that the EPC existed
- ☐ I didn't find it necessary
- ☐ I thought that the dwelling was already energy efficient
- ☐ It stated in the advertisement that it was not available
- ☐ Another, namely:

14 When did you first hear about the EPC for your new dwelling?
- ☐ It was in the advertisement for the dwelling
- ☐ When I viewed the property
- ☐ At the notary office
- ☐ From another source

15 Did the EPC have an influence on the purchase of the dwelling?
- ☐ Yes
- ☐ No Continue with question 18
- ☐ Don't know Continue with question 18

16 Can you indicate what influence the EPC had during the transaction? (multiple answers possible)
- ☐ The EPC influenced the decision to purchase the dwelling. Can you state how?
- ☐ The EPC had an influence on the sale price of the dwelling. Can you state how?
- ☐ The EPC influenced work that the seller carried out before the transfer of the dwelling.
- ☐ Another, namely:

17 Why did you ask for an EPC/energy audit? (multiple answers possible)
- ☐ I wanted to know more about the energy performance of my dwelling
- ☐ It was required for a subsidy application
- ☐ It was required for a loan application
- ☐ I thought it would help me to sell my dwelling

- ☐ I was advised to do this my estate agent/notary
- ☐ I was advised to this by another party (for example, the Association of Home Owners/local authority), please indicate which:
- ☐ For another reason, namely:

18 What is the energy rating of your dwelling according to the EPC?

- ☐ A
- ☐ B
- ☐ C
- ☐ D
- ☐ E
- ☐ F
- ☐ G
- ☐ Don't know

19 Which of the following measures were listed on your EPC/energy audit? (multiple answers possible)

- ☐ New condensing boiler
- ☐ High performance glass
- ☐ Roof insulation
- ☐ Floor insulation
- ☐ Wall insulation
- ☐ Heat recovery from the shower
- ☐ Heat recovery from mechanical ventilation
- ☐ Heating system/piping insulation
- ☐ Draught proofing
- ☐ Sustainable energy sources (e.g. heat pumps, sun panels etc.) namely:
- ☐ I can't remember
- ☐ None
- ☐ Another, namely:

20 You have indicated that the following measure was listed on your EPC/energy audit: high performance glass. Does this apply:

- ☐ To some rooms
- ☐ To all rooms
- ☐ I don't know

21 You have indicated that the following measure was listed on your EPC/energy audit: roof insulation. Does this apply to:

- ☐ Complete installation? (there is now none)
- ☐ Topping up? (improving what is already there)
- ☐ I don't know

22 You have indicated that the following measure was listed on your EPC/energy audit: floor insulation. Does this apply to:
- ☐ Complete installation? (there is now none)
- ☐ Topping up? (improving what is already there)
- ☐ I don't know

23 You have indicated that the following measure was listed on your EPC/energy audit: wall insulation. Does this apply to:
- ☐ Complete installation? (there is now none)
- ☐ Topping up? (improving what is already there)
- ☐ I don't know

24 There is a policy discussion in the Netherlands that the EPC system must be improved. It is probable that in 2012 a sanction will be applied if an EPC is not available at the sale of a dwelling. Sanctions are a requirement from the EC.
What do you find a suitable solution?
- ☐ The government carries out random checks on the presence of EPCs during sales. In the absence of an EPC there is a fine
- ☐ The dwelling cannot be transferred if the EPC is not made available at the notary stage
- ☐ The government issues every dwelling with a basic label

Another, namely:
- ☐ I don't know

Energy saving measures

In this section we ask about measures that save energy, for example, the replacement of a boiler or the topping up of insulation.

25 Have you carried out energy saving measures in your dwelling since 2008? (for example, the replacement of a boiler or insulation etc.
- ☐ Yes Continue with question 27
- ☐ No

26 Why did you not carry out energy saving measures? (multiple answers possible)
- ☐ My dwelling is already energy efficient
- ☐ Lack of finances
- ☐ I don't find it important
- ☐ I don't know how to go about it
- ☐ It is too much hassle
- ☐ I don't have the time for it
- ☐ I don't know how long I shall live in this dwelling

☐ Another, namely:

27 What measures have you carried out since 2008? (multiple answers possible)
- ☐ New condensing boiler
- ☐ High performance glass
- ☐ Roof insulation
- ☐ Floor insulation
- ☐ Wall insulation
- ☐ Heat recovery from the shower
- ☐ Heat recovery from mechanical ventilation
- ☐ Heating system/piping insulation
- ☐ Draught proofing
- ☐ Sustainable energy sources (e.g. heat pumps, sun panels etc.) namely:
- ☐ Another, namely

28 You have indicated that you carried out the following measures since 2008: high performance glass. Did you carry this out in:
- ☐ Some rooms
- ☐ All rooms
- ☐ I don't know

29 You have indicated that you carried out the following measures since 2008: roof insulation. Did you install this:
- ☐ Completely (there was no insulation
- ☐ As a top up (improving the insulation already present)
- ☐ I don't know

30 You have indicated that you carried out the following measures since 2008: floor insulation. Did you install this:
- ☐ Completely (there was no insulation)
- ☐ As a top up (improving the insulation already present)
- ☐ I dont know

31 You have indicated that you carried out the following measures since 2008: wall insulation. Did you install this:
- ☐ Completely (there was no insulation)
- ☐ As a top up (improving the insulation already present)
- ☐ I don't know

32 Can you indicate the reason for adopting the energy saving measure? (multiple answers are possible)
- ☐ Due to a poor EPC rating
- ☐ Because of recommendations on the EPC/energy audit

- ☐ To improve the comfort/aesthetics of the dwelling
- ☐ To reduce energy costs
- ☐ Because of the end of life of installations (for example, the boiler)
- ☐ To improve noise installation (for example, through high performance glass)
- ☐ To improve the value of my dwelling
- ☐ To experiment with new technologies, for example, solar panels
- ☐ Because a subsidy came available
- ☐ Because I got advice from family/friends
- ☐ For another reason, namely:

33 What were the costs (including possible subsidy) of the measures you carried out since 2008?

- ☐ Less than €500
- ☐ between €500 and €1000
- ☐ between €1000 and €2000
- ☐ between €2000 and €4000
- ☐ more than €4000

34 How did you finance the energy saving measures? (multiple answers are possible)
Savings

- ☐ Loan from family/friends
- ☐ Normal loan from a bank
- ☐ Special loan for energy saving measures
- ☐ Mortgage increase
- ☐ Subsidy
- ☐ Another, namely:

35 Is the comfort improved since the adoption of the energy saving measures?

- ☐ Yes
- ☐ No Continue with question 37
- ☐ Don't know Continue with question 37.

36 How have you noticed the improvement in comfort? (for example less draughts?)

37 Is energy use reduced since the adoption of energy saving measures?

- ☐ Yes
- ☐ No Continue with question 38.
- ☐ I don't know

38 How have you noticed this reduction in energy use? (multiple answers possible)

- ☐ From a meter
- ☐ From the energy bill
- ☐ Another, namely:

39 You stated previously that the EPC/audit had an influence on the energy saving measures that you adopted. Will you indicate below in which way the EPC/audit (including recommendations) had an influence

- ☐ Did the EPC lead you to adopt energy saving measures that you had previously not thought of?
- ☐ Did you have ideas about energy saving measures that were confirmed by the EPC/ energy audit
- ☐ Did the EPC lead you to adopt more energy saving measures than you had planned?

40 Did the EPC/audit have another influence on the adoption of energy saving measures? Yes, namely:

41 Have you had a new EPC since the adoption of the energy saving measures?

- ☐ Yes
- ☐ No Continue with question III BUILDING REGULATIONS

42 Is your EPC rating improved since the adoption of energy saving measures?

- ☐ Yes
- ☐ No Continue with question III BUILDING REGULATIONS
- ☐ I don't know Continue with question III BUILDING REGULATIONS

43 From which energy rating to which energy rating did your EPC improve?
The rating was and is now

- ☐ I don't know

Building works

In situations such as the renovation or extension of a dwelling it is sometimes necessary to apply for a building permit. Sometimes the renovation or extension gives the opportunity to adopt energy saving measures. In this section we would like to know if you carried out building works on your dwelling and if the building permit application procedure or/and the building works had an influence on the adoption of energy saving measures.

44 Have you carried out works in your dwelling since 2008 that required a building permit?

- ☐ Yes
- ☐ No Continue with question IV PLANNED ENERGY SAVING MEASURES

45 What works have you carried out?

46 Did you carry out energy saving measures in combination with the building works?

- ☐ Yes Continue with question 47
- ☐ No Continue with question 50
- ☐ I don't know Continue with question 50

47 Did the procedure around the building permit application and the building works influence the energy saving measures that you adopted? (for example, were you advised by the local authority or building contractor to install insulation?)

- ☐ Yes can you explain how? Continue with question 48.
- ☐ No Continue with question IV PLANNED ENERGY SAVING MEASURES
- ☐ I don't know Continue with question IV PLANNED ENERGY SAVING MEASURE

48 Will you please indicate below how the procedure around the application for a building permit or building works had an influence?

- ☐ Did the permit/building works lead you to adopt energy saving measures that you had previously not thought of?
- ☐ Did you have ideas about energy saving measures that were confirmed by the permit/building works?
- ☐ Did the permit/building works lead you to adopt more energy saving measures than you had planned?

49 Did the building process influence the energy saving measures that you adopted in another way?

- ☐ Yes, namely:
- ☐ No

50 Why did you not adopt any energy saving measures during the building works? (multiple answers possible)

- ☐ My dwelling is energy efficiency enough
- ☐ I did not have the finances
- ☐ I didn't find it important
- ☐ I didn't know how
- ☐ Too much hassle
- ☐ I didn't have the time for that
- ☐ Another, namely:

Planned energy saving measures

In this section we ask about your plans to adopt measures that can save energy, for example, the application of floor insulation or the installation of solar panels.

51 Do you plan on adopting (more) energy saving measures in the following two years?

- ☐ Yes
- ☐ No Continue with question V FINANCIAL INSTRUMENTS
- ☐ I don't know yet Continue with question V FINANCIAL INSTRUMENTS

52 What measures do you plan on adopting? (multiple answers possible)

- ☐ New condensing boiler
- ☐ High performance glass
- ☐ Roof insulation
- ☐ Floor insulation
- ☐ Wall insulation
- ☐ Heat recovery from the shower
- ☐ Heat recovery from mechanical ventilation
- ☐ Heating system/piping insulation
- ☐ Draught proofing
- ☐ Sustainable energy sources (e.g. heat pumps, sun panels etc.) namely:
- ☐ Another, namely

53 You have indicated that you plan on carrying out the following measure: high performance glass. Do you plan on carrying this out in:

- ☐ Some rooms
- ☐ All rooms
- ☐ I don't know

54 You have indicated that you plan on carrying out the following measure: roof insulation. Do you plan on installing this:

- ☐ Completely (there is no insulation)
- ☐ As a top up (improving the insulation already present)
- ☐ I don't know

55 You have indicated that you plan on carrying out the following measure: floor insulation. Do you plan on installing this:

- ☐ Completely (there is no insulation)
- ☐ As a top up (improving the insulation already present)
- ☐ I don't know

56 You have indicated that you plan on carrying out the following measure: wall insulation. Do you plan on installing this:

- ☐ Completely (there is no insulation)
- ☐ As a top up (improving the insulation already present)
- ☐ I don't know

57 Do you plan on adopting the measures you have indicated because of one or more of the reasons listed below?

- ☐ Due to a poor EPC rating
- ☐ Because of recommendations on the EPC/energy audit
- ☐ To improve the comfort/aesthetics of the dwelling
- ☐ To reduce energy costs
- ☐ Because of the end of life of installations (for example, the boiler)
- ☐ To improve noise installation (for example, through high performance glass)
- ☐ To improve the value of my dwelling
- ☐ To experiment with new technologies, for example, solar panels
- ☐ Because a subsidy came available
- ☐ Because I got advice from family/friends
- ☐ For another reason, namely:

58 How much do you plan on spending on energy saving measures?

- ☐ Less than €500
- ☐ between €500 and €1000
- ☐ between €1000 and €2000
- ☐ between €2000 and €4000
- ☐ > €4000

59 How do you plan on financing the energy saving measures? (multiple answers possible)
Savings

- ☐ Loan from family/friends
- ☐ Normal loan from a bank
- ☐ Special loan for energy saving measures
- ☐ Mortgage increase
- ☐ Subsidy
- ☐ Another, namely:

60 Do you plan on improving the EPC rating through the adoption of planned energy saving measures?

- ☐ Yes
- ☐ No Continue with question V FINANCIAL INSTRUMENTS
- ☐ I don't know Continue with question V FINANCIAL INSTRUMENTS

61 From which EPC rating to which EPC rating do you plan to improve?
From EPC rating to EPC rating

Financial instruments

This section is about financial instruments, such as, for example, subsidies that lower the price of solar panels. We would like to know if people are aware of these instruments and if they have been used what their precise influence has been.

62 Please indicate which of the following instruments you are aware of? (some are no longer available)

Meer met Minder subsidy

- ☐ Yes, I am aware of it
- ☐ No, I am not aware of it

Energy audit subsidy

- ☐ Yes, I am aware of it
- ☐ No, I am not aware of it

Lower VAT rate (for labour costs of insulation of floors, walls and roof)

- ☐ Yes, I am aware of it
- ☐ No, I am not aware of it

High performance glass subsidy

- ☐ Yes, I am aware of it
- ☐ No, I am not aware of it

Sustainable warmth subsidy (renewable technology)

- ☐ Yes, I am aware of it
- ☐ No, I am not aware of it

Green project loans

- ☐ Yes, I am aware of it
- ☐ No, I am not aware of it

Energy saving credit loan

- ☐ Yes, I am aware of it
- ☐ No, I am not aware of it

Sustainability loan

- ☐ Yes, I am aware of it
- ☐ No, I am not aware of it

Local authority/provincial subsidy

- ☐ Yes, I am aware of it
- ☐ No, I am not aware of it

63 Please indicate which of the following financial instruments you have used?

Meer met Minder subsidy

- ☐ I have used it
- ☐ I have not used it

Energy audit subsidy

- ☐ I have used it
- ☐ I have not used it

Lower VAT rate (for labour costs of insulation of floors, walls and roof)

- ☐ I have used it
- ☐ I have not used it

High performance glass subsidy

- ☐ I have used it
- ☐ I have not used it

Sustainable warmth subsidy (renewable technology)

- ☐ I have used it
- ☐ I have not used it

Green project loans

- ☐ I have used it
- ☐ I have not used it

Energy saving credit loan

- ☐ I have used it
- ☐ I have not used it

Sustainability loan

☐ I have used it
☐ I have not used it

Local authority/provincial subsidy

☐ I have used it
☐ I have not used it

64 Did the financial instrument(s) have an influence on the energy saving measures that you carried out?
☐ Yes
☐ No Continue with question VI ENERGY BILL AND ENERGY TAX
☐ I don't know Continue with question VI ENERGY BILL AND ENERGY TAX

65 Will you please indicate below the influence the Meer met Minder subsidy?

Did the Meer met Minder subsidy influence you to adopt more energy saving measures than you had planned?

☐ Yes
☐ No
☐ I don't know

Did the Meer met Minder subsidy influence you to adopt measures earlier than you had planned?

☐ Yes
☐ No
☐ I don't know

Did the Meer met Minder subsidy influence you to adopt energy saving measures that you would not have adopted without the subsidy?

☐ Yes
☐ No
☐ I don't know

66 Will you please indicate below the influence the lower VAT rate?
Did the lower VAT rate influence you to adopt measures earlier than you had planned?
☐ Yes
☐ No
☐ I don't know

Did the lower VAT rate influence you to adopt energy saving measures that you would not have adopted without the subsidy?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the lower VAT rate influence you to adopt more energy saving measures than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

67 Will you please indicate below the influence of the high performance glass subsidy?

Did the high performance glass subsidy influence you to adopt measures earlier than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the high performance glass subsidy influence you to adopt more energy saving measures than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the high performance glass subsidy influence you to adopt energy saving measures that you would not have adopted without the subsidy?

- ☐ Yes
- ☐ No
- ☐ I don't know

68 Will you please indicate below the influence the sustainable warmth (renewable technology) subsidy?

Did the sustainable warmth subsidy influence you to adopt measures earlier than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the sustainable warmth subsidy influence you to adopt more energy saving measures than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the sustainable warmth subsidy influence you to adopt energy saving measures that you would not have adopted without the subsidy?

- ☐ Yes
- ☐ No
- ☐ I don't know

69 Will you please indicate below the influence the green project loan?

Did the green project loan influence you to adopt measures earlier than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the green project loan influence you to adopt more energy saving measures than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the green project loan influence you to adopt energy saving measures that you would not have adopted without the loan?

- ☐ Yes
- ☐ No
- ☐ I don't know

70 Will you please indicate below the influence the energy saving credit loan?

Did the energy saving credit loan influence you to adopt measures earlier than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the energy saving credit loan influence you to adopt more energy saving measures than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the energy saving credit loan influence you to adopt energy saving measures that you would not have adopted without the loan?

- ☐ Yes
- ☐ No
- ☐ I don't know

71 Will you please indicate below the influence the sustainability loan?

Did the sustainability loan influence you to adopt measures earlier than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the sustainability loan influence you to adopt more energy saving measures than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the sustainability loan influence you to adopt energy saving measures that you would not have adopted without the loan?

- ☐ Yes
- ☐ No
- ☐ I don't know

72 Will you please indicate below the influence the local authority/provincial subsidy? Did the local authority/provincial subsidy influence you to adopt measures earlier than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the local authority/provincial subsidy influence you to adopt more energy saving measures than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the local authority/provincial subsidy influence you to adopt energy saving measures that you would not have adopted without the subsidy?

- ☐ Yes
- ☐ No
- ☐ I don't know

Energy bill and energy tax

This section is about your energy bill. You do not need to have your energy bill with you. It does not matter if you do not know the precise information.

73 How much is your energy bill per month?

- ☐ Approximately €
- ☐ I don't know

74 Are you aware of the energy tax on your energy use?

- ☐ Yes
- ☐ No Continue with question VII INFORMATION SOURCES

75 How much energy tax do you pay per month on your energy use?

- ☐ Approximately €
- ☐ I don't know Continue with question VII INFORMATION SOURCES

76 Does the amount of energy tax you pay influence your energy use?

- ☐ Yes

- ☐ No
- ☐ I don't know

Information sources

This section is about different information sources such as websites and telephone numbers that are available to help householders with information about energy saving measures. We would like to know if people are aware of these instruments and, if they were used, what the influence was.

77 Have you used websites where, through the input of details, you can get advice about subsidies, energy prices and energy saving measures etc? (for example, the 'energy price comparer' from the Association of Home Owners)

- ☐ Yes
- ☐ No Continue with question
- ☐ Maybe

78 Can you describe which websites you have used?

79 Are you aware of tailored advice about energy saving measures whereby a certified advisor visits and offers information about energy saving specific to your dwelling?

- ☐ Yes
- ☐ No

80 Please indicate if you have made contact with one or more of the following parties listed below to seek information about energy saving.

- ☐ The Association of Home Owners (VEH)
- ☐ Builders and Installers
- ☐ More with Less (Meer met Minder)
- ☐ Environment Central (Milieu Centraal)
- ☐ Energy Company
- ☐ National Energy Agency (AgentschapNL)
- ☐ Local Authority
- ☐ Another, namely:
- ☐ None of the above

81 In which way did you make contact with the organisations previously indicated? (multiple answers possible)

- ☐ Email
- ☐ Telephone
- ☐ Website
- ☐ Another

82 Did the information over energy saving measures that you in the above instances received have an influence on the energy saving measures that you carried out?

- ☐ Yes
- ☐ No Continue with question VIII HOUSEHOLD AND DWELLING DETAILS
- ☐ I don't know Continue with question VIII HOUSEHOLD AND DWELLING DETAILS

83 In what way did the information sources have an influence on the measures you took? Did the information you received lead you to take measures that you hadn't thought of before?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did you already have ideas in relation to the energy saving measures you conducted that were confirmed by the information you received?

- ☐ Yes
- ☐ No
- ☐ I don't know

Did the information you received lead you to carry out more energy saving measures than you had planned?

- ☐ Yes
- ☐ No
- ☐ I don't know

84 Did the information that you received have another influence on the energy saving measures that your carried out?

- ☐ Yes, namely:
- ☐ No

Household and dwelling characteristics

The last section is about your situation and your dwelling. Whether people take measures is dependent on a number of factors such as the type of dwelling where they live, income and work situation. We would like to know if instruments reach everyone or just some people.

85 What type of dwelling do you live in?

- ☐ Apartment
- ☐ Detached dwelling

- ☐ 2 under 1 roof
- ☐ Corner dwelling
- ☐ Attached dwelling
- ☐ Another, namely:

86 In what period was your dwelling constructed?
- ☐ Before 1945
- ☐ 1945-1970
- ☐ 1971-1990
- ☐ 1991-2000
- ☐ 2001 of later
- ☐ I don't know

87 How long have you been the owner of your dwelling?
- ☐ < 1 year
- ☐ 1 - 5 years
- ☐ > 5 years

88 Are you planning on moving?
- ☐ Yes, within 1 year
- ☐ Yes, between 1 and 5 years
- ☐ Yes, but in more than 5 years
- ☐ No

89 How many people are in your household (including yourself)?
- ☐ 1 Continue with question 9
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ >4

90 How many are over 18 years?

91 What year were you born?

92 What is the highest education level in your household?
- ☐ Primary school
- ☐ High school
- ☐ Vocational training I
- ☐ Vocational training II
- ☐ Vocational training III
- ☐ University
- ☐ Another, namely:

TOC

93 What is your work situation?

- ☐ Part-time work
- ☐ Full-time work
- ☐ Unemployed
- ☐ With pension
- ☐ Student
- ☐ Another, namely:

94 What is the net monthly income of your household?

- ☐ < € 1,000
- ☐ € 1,000 to € 1,350
- ☐ € 1,350 to € 1,800
- ☐ € 1,800 to € 3,150
- ☐ More than € 3,150
- ☐ I prefer not to say

95 Do you have any remarks about this questionnaire?

- ☐ Yes, namely:
- ☐ No

96 You can fill in your email address here for the lottery, results of this survey and further information. We will not use your email address for anything other than the reasons listed below.

- ☐ I would like to receive the most important findings of the research by email?
- ☐ I would like my email address added to the lottery for one of the TU Delft famous umbrellas?
- ☐ You can contactme by email to ask for more information about my answers?

My email address is:

Appendix 4

DENMARK

1 Is it accurate to say that the instruments that dominate policy action towards improving energy performance of existing dwellings (limited to space and water heating) are: Building regulations and the Energy Performance Certificate (Energy Label)?

2 Are these instrument(s) considered to form an effective combination?

3 It is understood that a comprehensive evaluation of the national energy instrument portfolio was conducted in 2008-

- Did this include building regulations?
- It was concluded from this evaluation that the Energy Performance Certificate is not cost effective – are there plans to, or has the EPC been altered as a result of this finding?

4 It is noted that changes to the EPC process have been made over the years e.g. the waiver option between buyers and sellers was removed

- Have changes like these improved the impact of EPCs?
- Are there now penalties in place if an EPC is not provided?

5 Is there discussion about introducing a form of regulation or obligation on householders (outside the renovation trigger point)?

6 Are there particular instruments in place for groups like private landlords, pensioners, immigrants or lower income householders?

- If no, are these groups considered to be reached by standard instruments?

7 Are instruments considered to offer long term action for energy performance in existing houses (to 2020 targets and beyond)?

8 Is energy efficiency considered the first goal of improving energy performance of buildings? (i.e. must an energy efficient thermal envelope be achieved before instruments supporting the installation of micro-generation technologies are adopted?)

9 Is a whole house approach promoted by the main instrument(s) – the notion that single measures will not achieve ambitious climate change goals but that deep whole house retrofit is required?

10 Is monitoring conducted following energy performance improvement to prove that energy consumption reduces as a result of measures?

11 Are the impacts of instruments like building regulations and the EPC consistently monitored?

12 Is it correct to say that single family dwellings escape the more rigorous demands of building regulations?
– If yes are there plans that single family houses will fall under regulations more in the future?

13 Are concerns that householders may renovate in smaller parcels to avoid regulations emerging as true?

14 Is overall energy consumption in Danish houses reducing?
If yes, is there a link made between instruments for existing dwellings and this reduction?

15 Is information available on annual costs of building regulations and EPCs and the predicted resulting annual CO_2 emission savings?

16 What is the average primary heat consumption for a dwelling in Denmark? [kWh/m^2/a]

GERMANY

1 Is it correct to say that the policy instruments that dominate federal action in Germany towards improving energy performance of existing houses are: KfW loans and grants and building regulations?

2 Do you consider that these instruments form an effective combination?

3 Are KfW and EnEV systematically monitored and evaluated?

4 During renovation householders can opt to meet component u-value requirements or show that the building as a whole does not exceed 140% of the energy requirements of new build- which option is most popular among householders?

5 Is there discussion about introducing a form of regulation or obligation on householders (or energy companies) in the future?

6 The EnEV issues general requirements such as insulating un-insulated areas between floors by 2011. Do requirements like these come into effect during renovation? If they also apply outside the renovation moment how are they implemented?

7 Are there particular profiles of householders who apply for KfW loans? (i.e. middle or higher income households)

8 Does the KfW loan and grant scheme design instruments for groups like pensioners, immigrants or lower income householders?
– If no, are there other instruments at federal level that do this or are KfW loans and grants considered to reach across different groups in existing dwellings?

9 Is it known how long KfW loans and grants will be active for? (2020?) Is there a funding guarantee until a certain date?

10 It is stated that 20 million households require energy performance improvement by 2020 and that KfW has reached approximately 1.5 million since 2001. To reach 2020 targets is it considered that KfW loans should be intensified or that other instruments are required?

11 Will tightening of the EnEV in 2012 be reflected in KfW loans? (A KfW 100 house would have to meet requirements of 2012 regulations?)

12 Is energy efficiency considered the first goal of improving energy performance of dwellings? (i.e. are loans/grants for micro-generation technologies only available if the building envelope has been optimally insulated?)

13 What are the annual costs and annual CO_2 emissions savings of Germany's efforts to improve energy performance of existing dwellings?

14 Is monitoring of household energy use conducted following energy performance improvement to prove that energy consumption reduces?

15 How do householders prove that energy performance of their houses has improved followed adoption of measures under the KfW loan?

16 Is overall energy consumption in German houses reducing?
- If yes, are KfW loans and grants and building regulations considered to be contributing to this?

17 What is the average primary heat consumption for a dwelling in Germany? [kWh/ m^2/a]

SWEDEN

1 Are targets like reduction of energy consumption per unit of heated area in homes by 20% by 2020 considered to be on track?

2 What can be said about the state of the Swedish stock in terms of energy efficiency? (Remaining cost effective savings).

3 Is it correct to say that the following instruments have 'dominated' national policy action for (space and water heating) in existing dwellings in Sweden:
- Procurement of energy efficient technologies
- Economic incentives – subsidies/tax relief/CO_2 tax
- Information tools – local energy advisors.

4 Is it correct to state that incentives focused on insulation and moved onto energy supply conversion over time?

5 Is it correct to state that instruments form a well working mix? (e.g. incentives encourage conversion to renewable energy supply-disincentives (CO_2tax) further encourage conversion)

6 What is the future plan for existing dwellings in terms of policy instruments?

7 Are the main national policy instruments targeted in any way towards, sub groups, for example, the private rental market or lower income households?

8 Is there discussion about imposing some form of energy performance obligation on households?

9 Is energy efficiency improvement always the first step with policy instruments? Can a subsidy for solar heating systems be received irrespective of the energy efficiency of the built envelope?

10 Do policy instruments reflect a 'whole house approach'

11 Are monitoring and evaluation programs in place that show cause and effect of policy instruments?

UNITED KINGDOM- OFGEM EXPERT

1 Does CERT work with other policy instruments to target energy performance of existing dwellings?

2 Is CERT considered to reach across sub-groups in existing dwellings such as private landlords?

3 Is energy efficiency considered the first goal of improving energy performance through CERT? (i.e. can micro-generation technologies be installed irrespective of the energy efficiency of the building envelop?)

4 Is a whole house approach promoted by CERT – the notion that single measures will not achieve ambitious climate change goals but that ambitious retrofit taking the dwelling as a whole is required?

5 It is understood that technical monitoring of 5% of recipients of CERT measures is conducted
- Are the results of this monitoring publicly available?
- What level of accuracy between predicted and actual energy savings is shown by results?

6 Is it correct to say that the costs of CERT to energy suppliers will be £5.5 billion in 2008-2012 and that these costs are recouped through household energy bills?

7 It is understood that lifetime savings of 293MtCO_2 are expected from CERT 2008-2012, for the interest of comparing with other countries what is this in annual savings of CO_2 emissions, or could you provide the calculation used to determine lifetime savings?

8 Is overall energy consumption in UK houses reducing? If yes, is a causal link with CERT made to explain this reduction?

9 What is the average primary heat consumption for a dwelling in UK? [kWh/m²/a]

UNITED KINGDOM – INDEPENDENT EXPERT

1 Do you consider CERT an effective instrument to reach the energy performance potential of existing dwellings in the UK?

2 Do you consider that CERT forms part of an effective combined instrument approach to existing dwellings?

3 Are groups such as private landlords, immigrants reached by CERT?
Can CERT be considered long term-with a planned operation to 2020 targets and beyond?

4 Is energy efficiency considered the first goal of improving energy performance of buildings? (i.e. can micro-generation technologies be installed without consideration for the energy efficiency of the building envelop?)

5 Is a whole house approach promoted by CERT – the notion that single measures will not achieve ambitious climate change goals but that ambitious retrofit taking building as a whole is required?

6 Is monitoring conducted following energy performance improvement to prove that energy consumption reduces as a result of measures?

7 Are the results of this monitoring publicly available?

8 Is information available on annual funding for energy performance improvement in exiting dwellings and annual CO_2 emission savings? (or similar units)?

9 Is overall energy consumption in UK houses reducing? If yes, is a causal link with CERT made?

10 What is the average primary heat consumption for a dwelling in UK? [($kWh/m^2/a$]

11 Is there discussion about introducing a form of regulation or obligation on householders in the future?

Curriculum vitae

Lorraine Murphy was born in Cork, Ireland in 1978. She graduated with a B.A. (Hons) in Geography and Archaeology from University College Cork, Ireland in 2000. She completed an MSc in Environmental Science at Trinity College Dublin in 2002. Following her studies she worked with the Environment Agency in London for several years. During this time she also volunteered for environmental non-government organisations. In 2008 she moved to the Netherlands and initially worked with an environmental consultancy before beginning a PhD research project at Delft University of Technology.