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Pay as You Save or Save As You Pay?

An evaluation of on-bill financing models for energy efficiency improvements

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Abstract

This thesis aims to shed light on the impact of the so-called Pay as You Save® (PAYS ®) or on-bill programmes for energy efficiency improvements in the building sector. These programmes are based on an innovative financing model that was developed to overcome several barriers to the up-take of energy efficiency measures by households and businesses. From the consumer's side, these barriers include high up-front costs often paired with a lack of available capital, inertia, disincentives due to long pay-back periods, risk aversion, split incentives between landlords and tenants and high transaction costs.

Despite increasing attention to innovative financing schemes for energy efficiency improvements, very little is known about the impacts of on-bill programmes. To fill this knowledge gap, an analysis comprised of three steps is carried out. Firstly, the intervention theory of the original PAYS ® system, as it was developed by the Energy Efficiency Institute, Inc. is analysed. Secondly, in an ex-post evaluation the How$mart® programme in Kansas (U.S.) and the Green Deal (UK) are portrayed and compared to the PAYS ® intervention theory with regards to their effectiveness in overcoming market barriers. The programmes are also compared between each other, inter alia the sources and scale of administrative and transaction costs. Thirdly, identified lessons learned are transferred to the German context where the introduction of new market-based instruments, in which on-bill programmes could play a role, is currently debated.

The findings suggest that carefully designed on-bill programmes, and particularly a sub-group of programmes that offers the installation and financing of energy efficiency measures as a service instead of a loan, are able to overcome market barriers such as high up-front costs, lack of finance, or the split incentive dilemma. The research results also highlight several limitations including low participation rates, limited ability to work as a purely market driven instrument, and high rebound effects, particularly in low-income households, that reduce the applicability for those consumers most in need.

A prerequisite for unsubsidised on-bill programmes to have an impact is that the costs of energy efficiency measures as well as programme costs can be financed through energy cost savings. Policy-makers and programme operators should therefore focus on reducing transaction and administrative costs attached to on-bill programmes by implementing simple and streamlined programme designs. Seeking access to low cost capital is another crucial facilitating factor.

Keywords: Energy efficiency, market barriers, on-bill, Pay as You Save, Green Deal, How$mart, transaction costs, market-based instruments, financing, split incentives

Executive Summary

To prevent dangerous levels of climate change it will be of key importance to change current patterns of energy use. According to a wide body of literature, there are significant untapped energy saving potentials that – if leveraged – could result in large greenhouse gas emissions abatements. The question arises why potentially cost-effective energy saving potentials have not been exploited to a larger extent. This apparent paradox has been often entitled as the "Energy Efficiency Gap", describing numerous market aspects and barriers that hinder the diffusion of profitable efficient technologies. The thesis at hand aims to shed light on so-called Pay as You Save® or on-bill programmes for energy efficiency improvements in the building sector. These programmes are based on an innovative financing model that was developed to overcome several barriers that inhibit the up-take of energy efficiency measures by households and businesses. Barriers that should be addressed on the consumer's side are: inertia, lack of available capital, disincentives due to long pay-back periods, risk aversion, the split incentive dilemma between landlords and tenants and high transaction costs. The Pay as You Save® (PAYS®) system also aims to reduce high administrative, transaction and financing costs on the provider's side.

Many states in the United States have introduced on-bill programmes. Each programme is unique in its design. However, all programmes have in common that costs are paid back by the consumer through a charge on the energy bill. While some programme operators offer to finance energy efficiency improvements at no up-front costs for the consumer in form of a loan that is repaid on the energy bill, others structure their product as an energy efficiency service. An innovative element is that the repayment obligation is not tied to one person, but to the energy meter of the building. If the first programme participant moves out the charge will be transferred to the next resident's energy bill. As the new resident will also enjoy the benefits from the installed energy efficiency measure, the overall energy bill should not be higher than before the measure's installation. With the Green Deal, the United Kingdom has been the first European country to introduce a policy framework that encourages private actors to offer on-bill models to residential customers.

Despite the growing interest in on-bill programmes, little is known about their performance and the emerging literature is rather fragmented. In fact, no comparative assessment has been carried out if or how on-bill programmes differ in their effectiveness in overcoming the identified market barriers due to their design as a loan or service. Furthermore, no transregional analysis has been published yet that compares the UK Green Deal with a programme in the U.S. The research objective of this thesis is to close this knowledge gap by carrying out a comparative ex-post evaluation of the Green Deal (policy driven) and the How$mart programme (private initiative), which was introduced by Midwest Energy, an energy cooperative in Kansas.

Given the fact that Germany has shown great interest in new market-based instruments, the thesis identifies lessons learned for policy-makers and transfers them to the German context. So far, no ex-ante evaluation has been carried for policy instruments encouraging on-bill programmes in the German context. The following research questions lay the foundation for the research design:

(1) Which critical factors have facilitated or hindered on-bill financing programmes' effectiveness in overcoming market barriers to energy efficiency improvements in the building sector? What can future on-bill programmes learn from existing on-bill experiences?

(2) Could a policy instrument that encourages on-bill financing programmes complement the German energy efficiency instruments mix in an effective manner and if so, how should a policy instrument be designed to accelerate the take-up of energy efficiency measures in Germany?

Methodological choices were driven by policy and programme evaluation literature. The research questions are addressed in a three-step analysis. First, the intervention theory of the original PAYS® system as it was developed by the Energy Efficiency Institute Inc. is analysed. It lays down the framework for a theory-based evaluation of two on-bill programmes. Second, the currently operating How$mart programme in Kansas and the UK Green Deal are described in detail and assessed against the PAYS® intervention theory. Furthermore, it is analysed how effective these two on-bill programmes have been in overcoming several barriers to investments in energy efficiency faced by small energy consumers. In a third step, the lessons learned are transferred to the German context. Here, the objective is to contribute to the debate on new market based instruments for energy efficiency improvements. Based on a multi-criteria framework an ex-ante evaluation is carried out to assess different policy design options that could be suitable for promoting on-bill programmes in Germany.

The findings from the ex-post as well as the ex-ante evaluation are based on secondary and primary research. A thorough review of the existing on-bill and wider energy efficiency and related economic literature was carried out, comprising academic publications as well as grey literature. Sixteen semi-structured interviews were carried out with experts on the Pay as You Save® system, the How$mart programme, as well as stakeholders from the UK and German energy efficiency policy arena, industry and civil society. These sources of qualitative data were complemented by a survey sent out to 45 Green Deal providers in the UK and Midwest Energy, the utility that runs the How$mart® programme in the U.S. The survey produced quantitative data on transaction, administrative and marketing costs related to the provision of on-bill programmes.

The main results can be summarised as follows. First, the findings from the ex-post evaluation show that carefully designed on-bill programmes can be regarded as a suitable instrument to overcome certain barriers to energy efficiency investments. Based on empirical findings as well as theoretical considerations, it can be argued that programmes that provide the installation and financing of energy efficiency measures as a service are more effective in overcoming market barriers than programmes providing on-bill loans. Overall, having the up-front costs covered by a third-party and attaching the payment obligation to the building's electricity or gas meter can be identified as the two essential facilitating factors for encouraging the up-take of efficiency improvements. If total costs can be recovered through energy savings, there is no need for the consumer to invest from his or her own pocket. Here, the barrier high-up front costs paired with lack of available finance can be overcome. Furthermore, by strictly tying the repayments to the beneficiary of the energy savings incentives can be aligned in a manner that solves the split incentives dilemma between landlords and tenants. Seeing an immediate benefit in form of lower energy bills and tying the payment obligation to the building's meter, reduces disincentives with regards to long pay-back periods. This is a particularly relevant design feature for consumers who face a high uncertainty how long they will occupy the same home or apartment. Even though not all consumers react to economic incentives, aligning the timing of cost and benefits can be regarded as a facilitating factor for reducing high levels of inertia related to consumers' implicit discount rates for future savings. If programmes are able to overcome consumers' risk aversion is highly dependent on the design in terms of required warranties and other mechanisms for consumer protection. Neither the analysed How$mart programme, nor the Green Deal delivers the kind of "unworried round the clock service

package", envisaged by the PAYS® system, as programme operators do not provide warranties for installed products over the entire payback period.

Second, from a provider's perspective investments made under on-bill programmes can be regarded as relatively secure. The rate of non-payment is usually below 1% as programme participants risk to be disconnected from utility services in case of non-payment. A limitation from a provider's perspective is on-bill programmes' limited ability to deliver a significant rate of return on investments made. However, it can still be regarded as a highly suitable instrument for yielding indirect benefits, such as gaining competitive advantage by increasing customer loyalty, image campaigning and experimenting with new business areas.

Third, the gathered data strongly suggests that on-bill programmes should be designed in a simple and streamlined manner in order to reduce transaction costs as far as possible. This leaves more financial resources for the energy efficiency investment itself. The survey results show that participating companies in the UK Green Deal face very high administrative and transaction costs as a result of an overly complex policy instrument design, a high number of involved actors, multiple and partly competing sources of finance and time consuming contractual sequences. Costs related to the accreditation process, marketing, administration and other transactions (such as contract negotiations) may exceed the total investments made in energy efficient technologies and their installation. Against this background, it is not surprising that interviewed Green Deal providers reported to be struggling to make a business case. In comparison, under How$mart programme costs only account for roughly 3% of total investments made. This large deviation can be explained by the Green Deal's highly complex policy design and related requirements in comparison to the simpler, utility-driven How$mart programme.

Fourth, even though no quantitative data could be gathered regarding transaction costs faced by consumers, these costs are assumed to be relatively high under the Green Deal for the same reasons. While more than 55% of customers taking decisions on programme participation signed up for the How$mart programme, only 1.2% of Green Deal assessments have translated into Green Deal financing plans. Overall, penetration rates of target populations ranged from 0.43% per year under How$mart to 0.006% per year under the Green Deal. This suggests that establishing a first contact to potential customers still seems to pose a major barrier to the scalability of on-bill programmes.

Fifth, the results of the ex-ante evaluation suggest that on-bill financing could complement the German energy efficiency instruments mix in an effective manner. It could target cost-effective energy saving potentials that are neither addressed by energy minimum performance standards, nor by the ambitious standards required under the KfW's soft loan programmes for energy efficiency improvements. Furthermore, if on-bill financing programmes are designed as a service agreement, it could be appealing to households and business that are unwilling or unable to take out a loan for investing in efficiency technologies.

It can be concluded that even though certain market barriers can be reduced through on-bill models, both analysed programmes, How$mart and the Green Deal are not able to show participation rates and the type of energy efficiency measures that would be needed to reduce energy use and related CO_2 emissions for meeting the EU's or Germany's efficiency and climate targets. On-bill financing models should therefore not be regarded as a "silver bullet" for leveraging finance into energy efficiency markets, but as one suitable instrument that can contribute to the tapping of unexploited energy saving potentials.

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Abbreviations

AC	Administrative cost
ARRA	American Recovery and Reinvestment Act
CDFI	Community Development Financial Institution
CERO	Carbon Savings Obligation
CERT	Carbon Emissions Reduction Target
DECC	Department for Energy and Climate Change (UK)
EBPG	Energiebetriebene-Produkte-Gesetz (Energy-driven Products Act, DE)
EEC	Energy Efficiency Commitment (UK)
EED	Energy Efficiency Directive (EU)
EEI	Energy Efficiency Institute, Inc. (Vermont, U.S)
EEWärmeG	Erneuerbare Energien Wärmegesetz (Renewable Energies Heating Act, DE)
EKF	Energie- und Klimafonds (Energy and Climate Fund, DE)
EnEG	Energieeinspargesetz (Energy Saving Act, DE)
EnergieStG	Energiesteuergesetz (Energy Tax Act, DE)
EnEV	Energieeinsparverordnung (Energy Conservation Ordinance, DE)
EPC	Energy Performance Certificate
ESCO	Energy Service Company
ESD	Energy Service Directive (EU)
ETS	Emission Trading System
EVPG	Energieverbrauchsrelevante-Produkte-Gesetz (Energy-related Products Act, DE)
GDFC	Green Deal Finance Company
GD ORB	Green Deal Oversight and Registration Body
GJ	Gigajoule
$GtCO_2eq$	Gigatonne CO_2 equivalent
HIF	Home Improvement Fund
HVAC	Heating, Ventilation, Air Conditioning
KfW	Kreditanstalt für Wiederaufbau
kWh	Kilowatt hour
NEEAP	National Energy Efficiency Action Plan
OBF	On-bill Financing
OBR	On-bill Repayment
PAYS	Pay as You Save
PJ	Petajoule
StomStG	Stromsteuergesetz (Electricity Tax Act, DE)
UK	United Kingdom

U.S.	United States
RdSAP	Reduced Data Standard Assessment Procedure
TC	Transaction cost
TWh	Terawatt hour
WSchVO	Wäremeschutzverordnung (Thermal Insulation Ordinance, DE)

1 Introduction

This chapter introduces the reader to the background of this thesis, the identified research problem and the resulting research objectives and research questions. Furthermore, it lays out the scope as well as the limitations of the research design.

1.1 Background to this thesis

Despite more and more stakeholders from the local to global level being engaged in climate change mitigation, global greenhouse gas emissions grew on average by 1.0 gigatonne carbon dioxide equivalent ($GtCO_2eq$) per year between 2000 and 2010, compared to 0.4 $GtCO_2eq$ per year from 1970 to 2000. Without additional efforts to reduce greenhouse gas emissions (GHG), the global mean surface temperature is likely to increase by 3.7°C to 4.8°C until 2100 compared to pre-industrial levels (IPCC, 2014b). Risks of death, injury, ill-health or disrupted livelihoods disproportionally rise with every additional centigrade of global temperature increase. Even if the 2°C target will be reached many species and ecosystems will be extinct, undermining the well-being of humans relying on these systems (IPCC, 2014c).

The increasing demand for energy currently drives an energy system that is largely based on the combustion of fossil fuels. It generates 35% of total anthropogenic GHG emissions (IPCC, 2014a). As humans do not demand energy per se, but the services energy provides us with, there are two major energy related strategies to reduce the likelihood of dangerous climate change. First, the combustion of fossil fuels needs to be drastically reduced by switching to renewable energies and other low carbon energy carriers (IPCC, 2014b). Second, the demand for energy services can be lowered by (1) increasing technological efficiency, (2) changing the structure of demand, e.g. by substituting physical mobility with electronic communications, and (3) reducing the absolute level of energy services demand, e.g. reducing travel needs by living closer to work and behavioural change towards voluntary sufficiency, e.g. by lowering the room temperature (Lopes, Antunes, & Martins, 2012; Notter, Meyer, & Althaus, 2013; Riahi et al., 2012). One sector where all of these strategies need to be significantly intensified is the building sector. According to the International Energy Agency (IEA, 2014), residential and commercial buildings account for one third of the global final energy demand. Without further action, by 2050 emissions from the global building stock may double or even triple by 2050, mostly due to increased access to housing at adequate standards as well as a rise of modern commercial buildings in low- and middle income countries.

The good news is that the potential for energy savings is vast (Jeffries, Deng, Cornelissen, & Klaus, 2012; Riahi et al. 2012). If today's cost-effective technologies and best practices are broadly diffused, the global trend of a rising energy demand could be turned around and absolute levels of energy use might be lower by mid-century than today (Barney et al., 2012; IPCC, 2014a). Saving potentials do not only lie in low- and middle income countries. According to a study carried out by Fraunhofer ISI (Boßmann, Eichhammer, & Elsland, 2012), the final energy demand of the European household sector could be reduced cost-effectively by 71% by 2050. Half of this potential lies in energy efficient refurbishments of building shells in existing homes.[1] Compared to other studies, this can be classified as one of the most optimistic estimates (European Commission, 2006, 2011; Tuominen, Klobut,

[1] The study is based on a technology-specific bottom-up simulation that was already applied in Eichhammer et al. (2009). The saving potential is derived by comparing the projected demand under the high efficiency scenario to the official baseline for energy demand used by European Commission from 2008. Only those technologies have been included where „financial savings for the avoided fuel procurement exceed the additional investments required to implement the efficiency technology" (Boßmann et al., 2012). A caveat is that cost-effective energy saving potentials were derived by assuming no transaction costs and perfect access to capital markets.

Tolman, Adjei, & de Best-Waldhober, 2012; WBCSD, 2009). Nevertheless, most studies come to the conclusion that there are significant cost-effective energy saving potentials, which have not been leveraged yet. The challenge of tapping these potentials has been acknowledged, but policy-makers struggle to meet politically defined efficiency targets. The European Union is not expected to achieve its indicative target of a 20% reduction in energy demand by 2020 compared to 1990 levels without further actions (European Commission, 2013). At the same time EU's member countries with the largest building stock, Germany and the United Kingdom, are struggling to meet their national energy efficiency and climate targets (BMWi, 2014; DECC, 2012a; Löschel, Erdmann, Staiß, & Ziesing, 2014; Tuominen et al., 2012).

This raises the question why potentially cost-effective energy saving potentials have not been exploited to a larger extent. This apparent paradox has been often entitled as the "Energy Efficiency Gap", describing the gap between "actual and optimal energy use" (Jaffe & Stavins, 1994, p. 804). There has been a heated debate around the notion of optimality, which is related to questions surrounding market barriers and failures as well as appropriate private and social discount rates for investments in efficiency improvements (Gates, 1983; Jaffe & Stavins, 1994; Sanstad & Howarth, 1994; Sutherland & Ronald, 2014). Sutherland & Ronald (2014) argue that there is no "Efficiency Gap", as observed consumer behaviour is privately optimal. Rational consumers apply high discount rates for energy efficiency investments due to their illiquid nature and a lack of risk diversification. Therefore, many apparent cost-effective efficiency measures would reveal themselves as unattractive under "real" market conditions. This view has been contested by many economists (Howarth & Sanstad, 1995; Jaffe & Stavins, 1994; Sanstad & Howarth, 1994; Tuominen et al., 2012). One major argument is that if market participants would maximise utility as predicted by economic theory, implicit discount rates for investments in energy efficiency would equal the rate-of-return of alternative investments with similar characteristics. However, consumers' applied discount rates significantly exceed market rates for both borrowing and saving (Dubin & Mcfadden, 1984; Howarth & Sanstad, 1995).[2] It is argued that these high implicit discount rates deviate from what would be suggested by standard economic theory, but can be (at least partially) explained by market barriers. New institutional economic theory explains the "Energy Efficiency Gap" with transaction costs (TCs) that move apparently cost-effective energy saving potentials into the uneconomic zone. Sources of TCs are related to information creation, collection and absorption, costs that are often not reflected in engineering studies calculating large energy saving potentials (Howarth & Sanstad, 1995; Jaffe & Stavins, 1994; Joskow & Marron, 1992). Other sources of TCs are related to due diligence, contract negotiations and monitoring of energy use and cost savings (Kiss, 2013; Mundaca, Mansoz, Neij, & Timilsina, 2013). TCs are particularly relevant in the residential sector where consumers' knowledge about levels of energy use as well as about costs and benefits of efficiency improvements are often limited (Stieß & Dunkelberg, 2013). Complex ownership structures and numerous small-scale energy saving opportunities further increase TCs. Another barrier are high up-front investment costs for energy efficiency measures, often combined with a lack of access to capital. Particularly low-income households are frequently required to pay risk premia or are unable to seek any kind of finance (Sanstad & Howarth, 1994). In addition, the illiquid and irreversible nature of most energy efficiency investments combined with payback periods of up to forty years create disincentives, particularly for consumers who face high uncertainty if they will see the long-term benefits, such as older people or tenants who tend to move more often (Berlo et al., 2011; Guertler & Royston, 2013). In the rental sector the "investor-user" or "principal-agent"

[2] Empirical research found discount rates ranging from 20% for room air conditioners, space heating and water heating investments (Dubin & Mcfadden, 1984; Hausman, 1979) over 45% to 300% for refrigerators (Gately, 1980) up to 800% for heating and cooling equipment (Ruderman, Levine, & McMahon, 1987).

dilemma, where the landlord (the investor) bears the costs, but the tenant (the user) enjoys a lower energy bill, further inhibits the introduction of energy efficiency (Guertler & Royston, 2013; Tuominen et al., 2012).

These barriers related to potentially high TCs and financing issues are complemented by consumers' bounded rationality in taking investment decisions. Even where high levels of subsidies are offered, consumers show a surprising level of inertia (Krarup & Russell, 2005). This phenomenon could be ascribed to high TCs related to solving "complex optimization problems" (Sanstad & Howarth, 1994, p. 815). However, research revealed systematic deviations from cost minimizing behaviour due to other factors such as the incapacity of processing information, loss aversion, reciprocity, habituation or self-identity affect decisions. These behavioural phenomena cannot be explained by information deficits alone (Gowdy, 2008; Gsottbauer & Bergh, 2010; Sanstad & Howarth, 1994; Zundel & Stieß, 2011).

1.2 Problem definition

Based on an analysis of the above described market barriers, so-called "on-bill programmes" were developed, which are based on an innovative financing model for energy efficiency measures. The financing model was designed to overcome many of the well-known barriers to efficiency improvements, such as uncertainties regarding long pay-back periods and high up-front costs. On-bill models bear some conceptual similarities to "energy performance contracting", which can be defined as "a contractual arrangement between the beneficiary and the provider (normally an Energy Service Company (ESCO)) of an energy efficiency improvement measure, where investments in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement" (Marino, Bertoldi, & Rezessy, 2010, p. 5). As under contracting models, it is not the consumer who pays for the up-front costs, but a third party, e.g. a utility or an ESCO. This should eliminate the barrier high up-front costs for energy users, which is often paired with a lack of capital. However, on-bill models share additional innovative characteristics that aim to eliminate other barriers that are still persistent under contracting. First, after the installation of the measure no new payment stream with the contractor or a bank is established. Instead a charge is put on the consumer's energy bill, which is not allowed to exceed the estimated energy cost savings yielded by the efficiency improvement. Seeing energy cost savings on the energy bill from the very start of the payback period, should provide consumers with an immediate benefit. Second, the payment obligation is not tied to the consumer, but to the building's energy meter. If the consumer moves out, the liability is transferred to the new resident (Bell, Nadel, & Hayes, 2011; Bell & Nadel, 2012; Cillo & Lachman, 2013; Lachman, 2013; UK-GBC, 2009).

Over the last decade on-bill programmes were introduced in more than twenty U.S. states. While some programmes were introduced voluntarily, others were mandated by policy-makers (Bell & Nadel, 2012; Cillo & Lachman, 2013; Hayes, Nadel, Granda, & Hottel, 2011). In 2013, the UK became the first European country to introduce a policy framework for encouraging the up-take of on-bill programmes through the so-called Green Deal[3] (Rosenow & Eyre, 2013). In practice, on-bill programmes differ in many aspects. One major distinction should be made: on-bill financing (OBF) is often based on the original Pay as You Save® (PAYS®) system, developed by the Energy Efficiency Institute, Inc. in Vermont, U.S. The essential feature of OBF is that the on-bill product is not designed as a loan, but as a service provided by the utility. This means that programme participants technically do not take out debt. The charge on the consumer's bill is a tariffed service charge. On-bill repayment (OBR) refers to

[3] The UK Green Deal relates to one specific policy framework for energy efficiency improvements in homes and businesses. It should not be confused with the "Green New Deal" discourse surrounding green economy and stimulus packages.

finance products that are based on a loan. Here, charges on the energy bill are loan instalments (Burr, 2013).

Despite the growing interest in on-bill programmes, little is known about their performance and the emerging literature about their impact is rather fragmented. In fact, no comparative analysis has been carried out if or how OBF and OBR programmes differ in their effectiveness in overcoming the identified market barriers. Furthermore, no transregional analysis has been published yet that compares the UK Green Deal with a programme in the U.S. This research gap will be filled by carrying out a comparative theory-based evaluation of the UK Green Deal (OBR) and the How$mart® programme in Kansas (OBF), which was introduced by the energy cooperative Midwest Energy, Inc. Out of the existing twelve OBF programmes in five U.S. states the How$mart® programme was chosen for three reasons: (1) its implementation closely follows the PAYS® system, (2) it is one of the more mature programmes dating back to 2007, (3) it is showing one of the highest participation rates (Bell & Nadel, 2012).

Other countries, such as Germany, have demonstrated a high interest in innovative market-based instruments for leveraging energy efficiency improvements. Germany was chosen as a particularly interesting case for an ex-ante evaluation. It is often cited as a forerunner in energy efficiency policies (IEA, 2013a). Nevertheless, Germany is currently struggling to meet its ambitious energy efficiency targets that are anchored in the "Energy Transition" towards a low carbon energy system (BMWi, 2014; Löschel et al., 2014). Against this background the government is discussing the introduction of new policy instruments. While there is a wider body of literature on the potential introduction of an energy company obligation or a tendering system (see: Becker et al., 2014; Bürger, Rohde, Eichhammer, & Schlomann, 2012; Dinges, Petersdorff, & Boeve, 2014; Schlomann, Becker, & Bürger, 2012), no ex-ante evaluation has been carried out for policy instruments that encourage on-bill programmes. This gap is closed by this thesis. The research objectives and questions are presented below.

1.3 Research Objectives and Questions

The overall research objective of the thesis at hand is to improve our knowledge about on-bill programmes for energy efficiency improvements. The aim is, based on ex-ante and ex-post policy evaluations, to generate knowledge about empirical and expected impacts about this emerging financing model in the field of energy and climate policy. As such, the thesis is policy oriented, which means that it is directed towards solving societal problems through improved public policies (F. Fischer, 1995; Hakim, 2000). The evaluation of the chosen cases aims to provide insights regarding critical market and policy conditions affecting the performance of on-bill programmes. While the How$mart® programme has been regarded as relatively successful (Johnson, Willoughby, Shimoda, & Volker, 2012), the Green Deal fell short of initial targets (Rosenow & Eyre, 2014). The differing performance raises questions about the design of the programmes and their effectiveness in overcoming the identified barriers such as high transaction costs or accessibility of low-cost finance.

Based on the lessons learned from Kansas and the UK, it will be analysed if the introduction of on-bill programmes could be an interesting option for tapping parts of the unexploited energy efficiency potential in Germany. It will be explored if on-bill financing could be embedded in the existing policy mix and be aligned with potential upcoming policies. An analysis of the German context will be accompanied by a bottom-up estimation of potential energy savings achieved by an introduction of on-bill programmes by all German electricity and gas providers. Against this background, the following research questions arise:

> *(1) Which critical factors have facilitated or hindered on-bill programmes' effectiveness in overcoming market barriers to energy efficiency improvements in the building sector? What can future on-bill programmes learn from existing on-bill experiences?*

(2) Could a policy instrument that encourages on-bill programmes complement the German energy efficiency instruments mix in an effective manner and if so, how should a policy instrument be designed to accelerate the take-up of energy efficiency measures in Germany?

To answer the research questions an analysis comprised of three steps is carried out. Firstly, the underlying intervention theory of the Pay as You Save® (PAYS®) system, as it was developed by the Energy Efficiency Institute, Inc. (EEI) is analysed. This analysis is carried out at the theoretical level. Secondly, in an ex-post evaluation the How$mart® programme in Kansas (U.S.) and the Green Deal (UK) are portrayed and compared to the original PAYS ® intervention theory with regards to their effectiveness in overcoming the identified barriers to investments in energy efficiency measures. The programmes will also be compared between each other, for example regarding the sources and scale of transaction costs. Thirdly, in light of the findings from the ex-post analysis, an ex-ante evaluation is carried out for the German context that is built on the multi-criteria framework laid down in chapter 2.1.3.

1.4 Research scope and (de)limitations

The initial research interest in the design and performance of on-bill models had to be narrowed to the case specific analysis of the Green Deal and the How$mart® programme. Five U.S. states have OBF programmes in place that are based on the PAYS ® system (see Annex IV) and there are many more OBR programmes in the U.S., which would have been very interesting to scrutinize as well in more detail. Due to time constraints, the geographical focus had to be narrowed on the How$mart® programme in Kansas. It was chosen as it is one of the more mature on-bill programmes and its design, targeting energy efficiency measures in households and business, matches the research interest in overcoming energy efficiency barriers for small energy consumers.

No further on-bill programmes for energy efficiency investments have been identified outside the U.S., besides the UK's Green Deal, which is more a policy framework than a government run energy efficiency programme. The choice of cases for a transregional comparative analysis was therefore restricted by the novelty of this innovative financing model. It needs to be acknowledged that comparing two countries with an Anglo-Saxon legal tradition (common law) reduces the transferability of the lessons learned to other jurisdictions, such as Germany. Furthermore, it was out of scope of this thesis to account for cultural differences between the three cases, U.S., UK and Germany, which might affect the acceptance and participation rates in on-bill programmes.

Another limitation regarding the interpretation of the differing performance of the analysed cases is that no in-depth comparative analysis of energy standards in the existing building stock and markets for energy efficiency technologies could be carried out in this thesis. To evaluate if a significant energy saving potential could be addressed by on-bill programmes in the ex-ante analysis for the German context, this limitation was addressed by an economic assessment of specific energy efficiency measures. This allowed to identify if under given conditions on-bill programmes might leverage cost-effective saving potentials in households and small businesses.

Regarding the access to data, there is a significant amount of grey literature, such as government reports, and a smaller amount of peer reviewed literature on on-bill programmes. The existing publications were complemented by primary data in form of interviews and a survey, designed for Green Deal Providers and Midwest Energy. While no major obstacles were faced in finding interview partners among researchers, policy-makers and also private actors, it proved to be difficult to gather quantitative data, particularly regarding the scale of administrative and transaction costs faced by on-bill providers. While some market actors

were reluctant to report data, as it was regarded as confidential, others faced difficulties in providing disaggregate estimates of transaction and investment costs due to internal accounting procedures. Overall, the results of the survey are not statistically reliable and can only give an indication of the sources and scale of transaction costs faced by providers.

1.5 Audience

This thesis is directed towards an academic audience, policy-makers and other stakeholders from the policy arena that are interested in innovative financing models for energy efficiency improvements. Furthermore, it should provide interesting insights to market actors, such as utilities and energy service providers that are open for new ideas and business models.

1.6 Disposition

In chapter 2, the reader will be introduced into the theoretical background of this thesis as well as into methods for data collection and analysis. Chapter 3 lays down the intervention theory of the Pay as You Save® system. Chapter 4 presents the findings of the ex-post evaluation of How$mart® and the Green Deal. Based on the insights from the ex-post evaluation, the results of an ex-ante analysis for the German context are presented in chapter 5. The results of this thesis will be embedded in the wider energy efficiency related academic literature in chapter 6. Here, methodological choices and key observations will be discussed as well. Chapter 7 concludes with the main findings and policy recommendations.

2. Methodology

This chapter introduces the reader to the underlying conceptual framework of this thesis. An overview over the theoretical background will be given, followed by an introduction into the specific analytical framework for the ex-post and the ex-ante evaluations, which lay down the method for data analysis. Furthermore, the methods for data collection are presented.

2.1 Methods for data analysis

The chosen methodology was driven by the concepts of policy-oriented research and policy evaluation. It is based on Vedung's approach that "Evaluating engenders looking backwards to improve forward direction. The specific role of evaluation is to systematically amass and assess information on intervention outcomes, outputs, and administration to produce adjustments, or more rational future decisions" (Vedung, 2009, p. 15). In this thesis, *public policy* is defined as "a political agreement on a course of action or (inaction) designed to resolve or mitigate problems on the political agenda" (Fischer, 2003, p. 50). Based on this definition, policies comprise government interventions as well as non-interventions. According to Mickwitz (2003, p. 419) interventions can be categorised as three types of policy instruments: *regulatory instruments* "aim at modification of the set of options open to agents", *economic instruments* "aim at altering the benefits and/or the costs of the agents", *information instruments* aim "at altering the priorities and significance agents attached to environmental issues". There is a comprehensive body of literature giving guidance on methods for policy evaluation (Bardach, 2005; Blumstein, Goldstone, & Lutzenhiser, 2000; F. Fischer, 1995; Mickwitz, 2003; Rossi, Lipsey, & Freeman, 2004; Vedung, 2009). Among the different streams of policy evaluation, this research is locating itself in the post-positivist position by adapting a critical view of the "fact-value dichotomy" principle. The "fact-value dichotomy" demands a strict separation of facts and values, by isolating empirical research from the normative context or implications (Fischer, 1998). This thesis is analysing on-bill programmes for energy efficiency improvements in light of a social problem, the unsustainable patterns of energy production and usage. It aims to produce 'knowledge for action', in this case for climate change mitigation, and is therefore clearly embedded in a normative context.

The unit of analysis will be the *case study*. The strength of case study research lies in an empirical enquiry of complex contemporary phenomena (cases) in their context by providing in-depth insights and fostering the understanding of how, when and why certain events occur (Yin, 2014). The analytical framework for the two cases, How$mart® and the Green Deal, that will be studied in an ex-post evaluation is presented the following section. The multi-criteria framework for studying the third case, Germany, is presented in section 2.1.3. Background information on the three cases will be introduced in section 4.1.1., 4.3.1. and 5.1.

2.1.1 A theory-based framework for the ex-post evaluation

The introduction of on-bill models is not necessarily policy driven. Certain design elements, e.g. tying the payment obligation to the building's meter, usually require a legal foundation, but programmes may not necessarily be triggered by public policy. For example, Midwest Energy voluntarily introduced the How$mart® programme and then lobbied for a change in the legislative framework that allows to structure the on-bill product as a tariffed service. Policy evaluation frameworks (e.g. Mickwitz, 2003) would not have been applicable for the ex-post evaluation of this programme. After a review of evaluation frameworks, a theory-based approach has been chosen, as it was regarded as particularly suitable for the evaluation of programmes that seek social change, without mandating the initiator of the programme to come from the public policy arena (Kahan, 2008). The underlying assumption of theory-based evaluations is that well targeted policies and programmes need to be grounded in a plausible

theory establishing how the policy or programme is intended to achieve its desired effect (Blumstein et al., 2000). The theory, also called intervention theory (Vedung, 2009), is basically an explanation of the causal mechanism that makes a programme work. If a programme or intervention does not produce its desired outcome, the two plausible explanations are that the underlying theory has had flaws or that the theory was not implemented correctly in practice. The task of the evaluator is to dig into the case and find what made the programme work and what inhibited its success. With a focus on the identification of causal linkages, theory-based approaches attempt to go beyond a simple goal-attainment evaluation, which primarily compares the measured outcome of a policy with the pre-defined goal (Blumstein et al., 2000).

Pawson's and Tilley's (1997) framework *Realistic Evaluation* is applied to the theory-based analysis of the PAYS® system and the ex-post evaluation of the How$mart® programme and the Green Deal. The framework was chosen as it was developed to systematically identify strengths and weaknesses of programmes that seek social change. The framework has been applied by the authors for the evaluation of crime prevention programmes. Since *Realistic Evaluation* has been published in 1997, it was cited more than 3000 times and has been applied for evaluating programmes in various contexts, such as healthcare, rehabilitation and education (GoogleScholar search, September 9, 2014).

Pawson and Tilley established guidance for a "realistic explanation of programs [which] involves an understanding of their mechanisms, contexts, and outcomes, and so requires asking questions about the reasoning and resources of those involved in the initiative, the social and cultural conditions necessary to sustain change, and the extent to which one behavioural regularity is exchanged for another" (Pawson & Tilley, 1997; p. 154). Instead of asking "does a program work?" it is asked "what is it about a program that works for whom?". This is done by "identifying mechanisms [which] involves the attempt to develop propositions about what it is within the program which triggers a reaction from its subjects" (Pawson & Tilley, 1997; p. 66). The underlying rationale is that outcomes can only be understood by analysing the mechanisms constituting regularities by an interplay of structure of agency and the context in which these mechanisms turn causal potential into causal outcome. It is acknowledged that programs are embedded in an existing set of social conditions that are of crucial importance for understanding the success or failure of social programmes. The basic realist formula can be expressed as:

$$mechanism + context = outcome.$$

Against this background programme evaluators need address the two questions: (1) *What are the mechanisms for change triggered by a program and how do they counteract the existing social processes?"* and *(2) "What are the social and cultural conditions necessary for change mechanisms to operate and how are they distributed within and between program contexts?"* (Pawson & Tilley, 1997; p. 75, 77).

Pawson and Tilley (1997) assume that social programmes emerge from the identification of behavioural patterns (T), creating certain regularities (R_1), which are perceived as problematic. This underlying assumption is perfectly applicable to the introduction of energy efficiency programmes, which depart from the social regularity "consumers saying *no* to efficiency improvements" (or saying nothing at all, which has the same outcome as a *no*). This regularity might be regarded as a problem and lead to the introduction of programmes that foster the up-take of energy efficiency measures, even though underlying motivations for introducing these programmes can differ significantly, ranging from climate policy goals, over energy security to building up a new business area for private companies. Pawson and Tilley elaborate that undesired regularities evolve from underlying, explanatory mechanisms (M_1). By introducing new social programmes, policy-makers or programme designers try to trigger a

shift in the pattern of behaviour in question into the direction of a desired pattern (R_2). Pawson and Tilley assume that programmes are effective when new or several new mechanisms ($M_2 – M_x$) break with the old mechanism (M_1) and the desired behavioural pattern (R_2) replaces the old one (R_1). The shift from R_1 to R_2 is the outcome (O) of the intervention. C_1 stands for context. This *Realistic Evaluation* framework is illustrated in Figure 1.

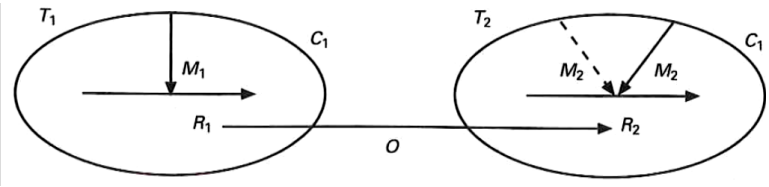

Figure 1 - "Basic ingredients of successful programmed social change"

Source: Pawson & Tilley (1997; p. 74)

With regards to the cases under analysis, these programmes have in common that they want to depart from the social regularity "consumers saying *no* to efficiency improvements" and aim for "consumers saying *yes* to efficiency improvements". In the terminology of Tilley and Pawson (1997) this is the shift from the regularity of inaction (R_1) to action (R_2). As outlined before, there are barriers to consumers' up-take of energy efficiency improvements, which can be described as mechanisms (M_x) that enforce the regularity of inaction (R_1). In chapter 3, it will be analysed on a theoretical level how the original PAYS® system aims to overcome eight inhibiting mechanisms, or barriers (B_{1-8}), by introducing new enabling mechanisms (M_{1-8}). These barriers under analysis are: $B_{1:}$ inertia, $B_{2:}$ lack of available capital and/or liquidity preferences, $B_{3:}$ disincentives due to long pay-back periods, $B_{4:}$ risk aversion, $B_{5:}$ split incentives, $B_{6:}$ high transaction costs on the consumer's side, $B_{7:}$ high transaction costs on the provider's side, $B_{8:}$ high financing costs. The eight barriers have been identified as relevant inhibiting mechanisms in a review of energy efficiency literature (Guertler & Royston, 2013; Howarth & Sanstad, 1995; Jaffe & Stavins, 1994; Mundaca et al., 2013; Stieß & Dunkelberg, 2013; Tuominen et al., 2012). They have already been briefly presented in chapter 1. The barriers as well as the PAYS® mechanisms to overcome these barriers will be laid down in more detail in chapter 3. In chapter 4, after introducing the reader to the context of the How$mart® programme and the UK Green Deal, the eight barriers will build the structure of the comparative ex-post evaluation of the on-bill programmes. It will be assessed which "mechanisms for change" were triggered by the programmes to address these barriers and how effective these mechanisms were in inducing social change. It will also be assessed in which aspects the programmes deviate from the PAYS® intervention theory and if these deviations provide explanatory value for understanding the programmes' performance.

2.1.2 Conceptual choices for analysing transaction costs

A transaction cost (TC) analysis under the ex-post evaluation of How$mart® and the Green Deal, needed to be based on several conceptual choices. These are presented in the following section, which introduces the reader to the theoretical foundation of the TC analysis.

The concept and analysis of transaction costs is one of the fundamental components of the school of New Institutional Economics (Ménard, 2004). In New Institutional Economics in general and in academic literature on the diffusion of energy efficiency technologies in particular, there is an on-going debate which cost components exactly constitute transaction costs (TCs). This applies in particular to the boundary between administrative and transaction costs. While Joskow & Marron (1992a), McCann et al. (2005), Stiglitz (1986) include administrative costs in their definition of TCs, other authors narrow the definition of TCs to ex-ante and ex-post activities, not directly related to drawing up the contract as such

(Furubotn & Richter, 2010; Matthews, 1986; Mundaca et al., 2013). This thesis follows the definition provided by Matthews (1986, p. 906): "[TCs are] the costs of arranging a contract ex ante and monitoring and enforcing it ex post, as opposed to production costs." Under this definition, common sources of TCs for investments in energy efficiency are related to time devoted to gathering, assessing and applying information, making decisions on technologies and usage, due diligence, contract negotiations and contract enforcement as well as monitoring and verification costs (Mundaca et al., 2013; Sanstad & Howarth, 1994).

Figure 2 illustrates how TCs determine the price level for certain quantities of energy savings. A supply curve can be surrogated based on the marginal costs of providing one more unit of energy savings. The demand curve represents the private marginal benefits for one extra unit of energy savings. The y-axis is depicted in monetary terms and the x-axis represents the quantity of leveraged energy savings. Taking the first supply curve (S), a good amount of energy savings can be yielded at negative costs, which means that the efficiency improvement yields monetary savings from a lifecycle perspective (Joskow & Marron, 1992). The equilibrium level at Q_E illustrates the level of energy savings that would be yielded in the absence of TCs. Adding TCs faced by providers to the marginal costs, shifts the supply curve upwards and to the left (S´) with the effect of decreasing energy savings, falling from Q_E to $Q´_{(TCs)}$, and a higher price per saved energy unit, moving from P_E to $P´_{(TCs)}$.

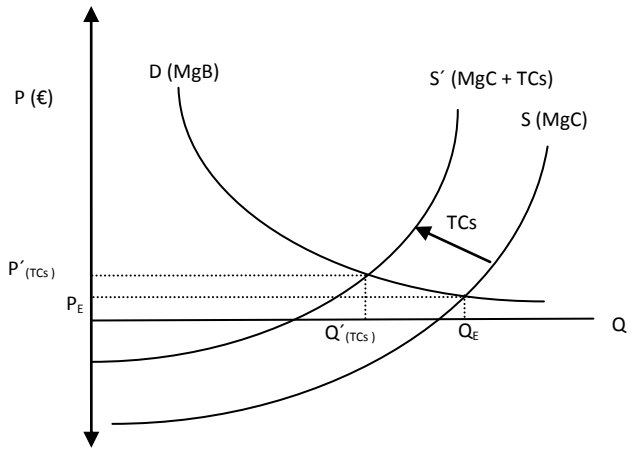

Figure 2 - Impacts of administrative and transaction costs on price and quantity of energy savings

Source: Own illustration based on Mundaca et al. (2013)

The focus of the transaction costs analysis of the How$mart® and Green Deal lies on TCs borne by the utility Midwest Energy and Green Deal Providers. The author acknowledges that there is a very fine line between ACs and TCs. To provide greater clarity in the data analysis, administrative and marketing costs have been assessed separately from TCs in the survey sent to on-bill financing providers.

While energy consumer and public authorities who oversee energy efficiency programmes also face TCs, these costs will not be part of the TC analysis. Assessing opportunity costs of exchanging appliances and equipment before the end of their lifetime would be highly interesting from a life-cycle perspective (Joskow & Marron, 1992), but are also not assessed.

2.1.3 A multi-criteria framework for the ex-ante evaluation

The ex-ante evaluation of policy instruments for encouraging a potential introduction of on-bill financing in the German context draws from all findings of the ex-post evaluation of the How$mart® programme and the Green Deal. A multi-criteria framework is applied as "evaluation is by nature normative and thus […] criteria on which to base the normative

judgements must be utilized" (Mickwitz, 2003, p. 425). For this purpose, Mickwitz' (2003) general criteria for the evaluation of environmental policies were chosen. Mickwitz' multi-criteria framework was regarded as particularly suitable for a first ex-ante evaluation that seeks to clarify if introducing a policy instrument for encouraging on-bill programmes might be an interesting option in the German context. Based on this general ex-ante evaluation an economic evaluation, such as a cost-benefit analysis (also called efficiency analysis by Vedung (2009)) could be carried out in a second step. However, the application of economic or democracy-related criteria, e.g. legitimacy, was out of scope for this thesis. The six criteria from Mickwitz (2003) and their application for the ex-ante evaluation are presented in Table 1.

Table 1 - Criteria for the ex-ante evaluation of policy instruments that encourage on-bill finance models in the German context based on Mickwitz (2003)

Criteria	Related questions from Mickwitz (2003, p. 426)	Case-specific questions
Relevance	Do the goals of the instruments cover key environmental problems?	Does on-bill financing address key energy efficiency related problems in the German context?
Impact	Is it possible to identify impacts that are clearly due to the policy instruments and their implementation?	Is it possible to identify impacts that would be due to a policy instrument that encourages on-bill models and their implementation?
Predictability	Is it possible to foresee the administration, outputs and outcomes of the policy instrument? Is it thus possible for those regulated, as well as others, to prepare and take into account the policy instrument and its implications?	Can administration, outputs and outcomes of design options for a policy instrument that encourages on-bill models be foreseen?
Effectiveness	To what degree do the achieved outcomes correspond to the intended goals of the policy instrument?	To what degree can on-bill programmes deliver outcomes in light of overall energy efficiency goals and specific goals of the policy instrument?
Persistence	Are the effects persistent in such a way that they have a lasting effect on the state of the environment?	Are yielded energy savings persistent in such a way that they have a lasting effect on absolute energy use?
Flexibility	Can the policy instrument cope with changing conditions?	Can the policy instrument for on-bill programmes adapt to changing conditions?

To evaluate the *relevance* of a policy instrument that encourages on-bill programmes, the reader will be introduced to the current policy mix for energy efficiency. Existing literature is reviewed (Becker et al., 2014; Blazejczak, Edler, & Schill, 2014; Löschel et al., 2014; Martin Pehnt et al., 2011; Stieß & Dunkelberg, 2013) to identify if there is a gap in the efficiency instruments mix, which might (partly) be filled by on-bill models.

For assessing the potential *impact*, in a first step the results of a literature review will be presented regarding unexploited energy efficiency potentials in the German residential sector and the commercial sector, comprising firms that are not engaged in farming, manufacturing, or transportation (Blazejczak et al., 2014; Martin Pehnt et al., 2011). It should be noted that on-bill programmes might also be a suitable instrument to encourage efficiency improvements in industry. An analysis of the needs and saving potentials industry was out of scope of this thesis for two reasons. First, how to successfully tap energy saving potentials in industry is highly sector specific. Due to time constraints no analysis could have been carried out of the

specific industrial sectors represented in Germany. Second, larger energy consumers already have access to energy-saving-contracting models, in contrast to households (Berger & Schäfer, 2009).[4] Therefore, preference has been given to the residential sector as the added value of on-bill programmes might be higher than in industry. The transport sector has also been excluded from this analysis as the focus lies on energy use in buildings, even though pilots with a similar logic are under development (Leber, 2014). In a second step, existing data on costs and benefits of specific energy efficiency technologies (Becker et al., 2014; BMVBS, 2012a, 2012b; Burr, 2013) is used to identify measures that could be suitable for on-bill financing.

Several policy design options are evaluated, which vary in their degree of coerciveness and *predictability* of administration, outputs, in terms of on-bill programmes on the market, and outcome, in terms of energy efficiency measures installed and financed under these programmes. A policy instrument that obliges all energy providers to offer on-bill programmes to their customers (without mandated energy saving targets) is chosen for a bottom-up calculation of potential energy savings. The results of this calculation are used to evaluate the instrument's *effectiveness* in terms of induced energy savings related to this specific policy instrument in light of Germany's wider energy efficiency targets. Other policy design options will also be discussed, but are not underpinned by an assessment of induced energy savings. Furthermore, it will be discussed how *persistent* these savings might be in light of the existing literature on the so-called "rebound effect" which (partly) offsets yielded energy savings.[5] Regarding the criterion *flexibility*, it will be evaluated how a policy to encourage on-bill financing could interact with policy instruments that are currently discussed in the German energy efficiency policy arena.

2.2 Methods for data collection

To increase reliability, methods for data collection followed the principle of triangulation, described as "the attempt to get a fix on a phenomenon or measurement (and, derivatively, an interpretation) by approaching it via several independent routes" (Scriven, 1991, pp. 364–354). Secondary data as well as primary data was gathered from a variety of sources, which will be presented in more detail in the following paragraphs.

The research for this thesis started with a screening of on-bill programmes all over the world. Academic literature as well as grey literature, such as government websites, reports or publications from non-governmental organisations was covered to provide a comprehensive overview over a variety of perspectives. As no on-bill programmes were identified outside the U.S. and the UK this resulted in an in-depth literature review with a narrowed geographical scope. Based on this review, the How$mart® programme in Kansas, US and the UK Green Deal were chosen as the cases for the ex-post analysis. All relevant secondary sources on these two programmes were consulted. For the ex-ante analysis, literature was consulted on the

[4] A small number of utilities introduced mini-contracting programmes for energy efficiency improvements in households. Examples are the the programme for replacing inefficient refrigerators in low-income households, which is run by Wuppertaler Stadtwerke (WSW, 2013) or the programme for exchanging heating pumps and hydraulic balancing, run by Stadtwerke Tübingen (Berlo et al., 2011). Overall, these programmes are only available to a small share of households.

[5] In the academic literature different types of "rebound effect" are classified. For on-bill financing it is relevant to educate consumers about the micro-economic, direct rebound effect as it might partly or fully offset the estimated energy cost savings. This type of "rebound effect" describes the phenomenon where "Improved energy efficiency for a particular energy service will decrease the effective price of that service and should therefore lead to an increase in consumption of that service. This [increase in consumption] will tend to offset the reduction in energy consumption provided by the efficiency improvement" (Sorrell & Dimitropoulos, 2008, p. 637). The magnitude of direct "rebound effects" remains heavily debated and ranges from 1-3% to a complete offset of energy savings. However, most estimates are between 15 and 30% (Berkhout et al., 2000; Greening et al., 2000; Sorrell & Dimitropoulos, 2008).

German energy efficiency policy landscape, remaining energy saving potentials as well as data on costs and benefits of specific energy efficiency measures. Along the case specific research, academic literature and evaluations of transaction costs related to energy efficiency programmes in other contexts were scrutinised. The literature review on the field of study was accompanied by a review of analytical frameworks for energy (efficiency) policy evaluation.

Based on insights from existing literature, relevant stakeholders were identified, contacted and interviewed for the purpose of the ex-post evaluation. The applied guidelines for the semi-structured interviews are attached in Annex I. All interviewees had the opportunity to review the statements attributed to their name. Furthermore, interviewees could choose to remain anonymous. To gain a better understanding of the original PAYS® system a telephone interview was carried out with Harlan Lachman from the EEI followed by frequent e-mail communications. For the evaluation of How$mart®, Michael Volker, the former Director of Regulatory and Energy Services at Midwest Energy, was interviewed, also followed up by e-mail communications. With regards to the evaluation of the Green Deal, various face-to-face interviews with three Green Deal Providers, a representative of the Department for Energy and Climate Change (DECC) as well as a representative from the Green Deal Finance Company (GDFC) were highly relevant sources of information for getting a clear understanding of the design and functioning of the Green Deal. Further, questions on the history and design choices were clarified and discussed via two telephone interviews with Jan Rosenow (Researcher and Senior Consultant at Ricardo-AEA Group) and Kirsty Neale (former DECC employee who was involved in the development of the Green Deal). The representative from DECC, Zoe Leader (Energy Efficiency Policy Officer, WWF-UK) and Steven Heath (Director for Public Affairs at Knauf Insulation Northern Europe) were already interviewed in March 2014 for a previous (unpublished) paper on the Green Deal. The insights gained are also presented and discussed in this thesis.

These sources of qualitative data were complemented by a survey sent out to 45 Green Deal providers in the UK and Midwest Energy in the U.S. The major purpose of designing the survey was to get quantitative data on transaction, administrative and marketing costs related to the provision of on-bill products. The questionnaire for Green Deal providers also comprised questions on obstacles and barriers faced by the companies as well as open questions regarding suggestions for improvements of the Green Deal policy framework. Six providers participated in the survey. Four providers used the online survey, one responded in a face-to-face interview and one provider responded on the phone. The questionnaire and participants' responses are available in Annex II & III and inserted in the relevant sections of the ex-post evaluation, presented in chapter 3. Another interviewed provider was still in the preparatory phase of selling the first Green Deal Plans. As most questions of the survey were targeted at providers that have already gained experiences with selling Green Deal Plans, the provider did not participate in the survey, but delivered highly valuable insights on the design and functioning of the accreditation process and the Green Deal in general.

For the ex-ante analysis, interviews with various stakeholders from the German energy efficiency context were carried out to get a preliminary feedback on a potential application of on-bill financing and related policy-instruments. First, interviewees from the energy efficiency policy arena as well as market actors were presented with the concept of the PAYS® system in its original form and were asked on potential obstacles that might need to be addressed in the German context. Second, experiences from the U.S. and the UK were presented and discussed with the interviewees. Interview partners were Michael Blohm (Federal Ministry for Economic Affairs and Economy, BMWi), Reinhard Loch (Head of the Energy Efficiency Unit at the Consumer Association, VZ NRW), Frank Schillig (Managing Director at KWA Eviva GmbH), Andreas Mucke (representative of local electricity provider, Wuppertaler Stadtwerke).

3. Analysis of the Pay as You Save® intervention theory

The following chapter provides the reader with a theoretical analysis of the Pay as You Save (PAYS®) intervention or programme theory. The EEI developed the PAYS® system as a template for designing OBF programmes in 1999 (Burr, 2013). To protect the intellectual property rights of the model, the EEI trademarked the name and the acronym within the U.S. The developers have provided the design and consulting services to five utilities that introduced OBF programmes based on the PAYS® system (Lachman, 2013). For an overview see Annex IV. The term "Pay as You Save" is often used for other types of on-bill models or even contracting solutions that bear little resembles with the EEI design (UK-GBC, 2009). In this thesis, the term is only used for the PAYS® system developed by the EEI. On-bill programmes without the trademark will be categorised as OBF (energy efficiency service) and OBR (loan) programmes.

In the following analysis, each section elaborates on how a new mechanism for change (M_x) aims to overcome a certain barrier (B_x) to investments in energy efficiency. This analysis is based on Pawson and Tilley's (1997) "Realistic Evaluation" framework, as it was outlined in chapter 2.1.1.

$M_1 \rightarrow B_1$ – *Inertia:* Inertia can be defined as "a tendency to do nothing or remain unchanged" (Inertia, n.d.). Even where large subsidies are offered for energy efficiency measures, consumers tend to not respond with a high take-up (CCC, 2009; Krarup & Russell, 2005). This can be partially explained with information deficits, but also with limited capabilities to translate information into calculations comparing the costs and benefits of the efficiency measure (Sanstad & Howarth, 1994; Zundel & Stieß, 2011). The PAYS® strategy for overcoming high levels of inertia is to actively approach the consumer and to do the maths on costs and benefits for him or her. It is usually the utility or a contractor who contacts consumers with high levels of energy use and offers to install efficiency measure(s) at no up-front costs. Under PAYS®, all measures are eligible where the costs can be repaid through monthly chargers over 75% over the measure's life time and where monthly charges are not higher than 75% of expected yielded energy cost savings. The following exemplary calculation is intended to clarify how the PAYS® system could be applied for the exchange of an old standard gas boiler to a new condensing gas boiler (with a lifetime of 19 years) in a single-family home (see Figure 3). Data was taken from the German context (BMVBS, 2012a).

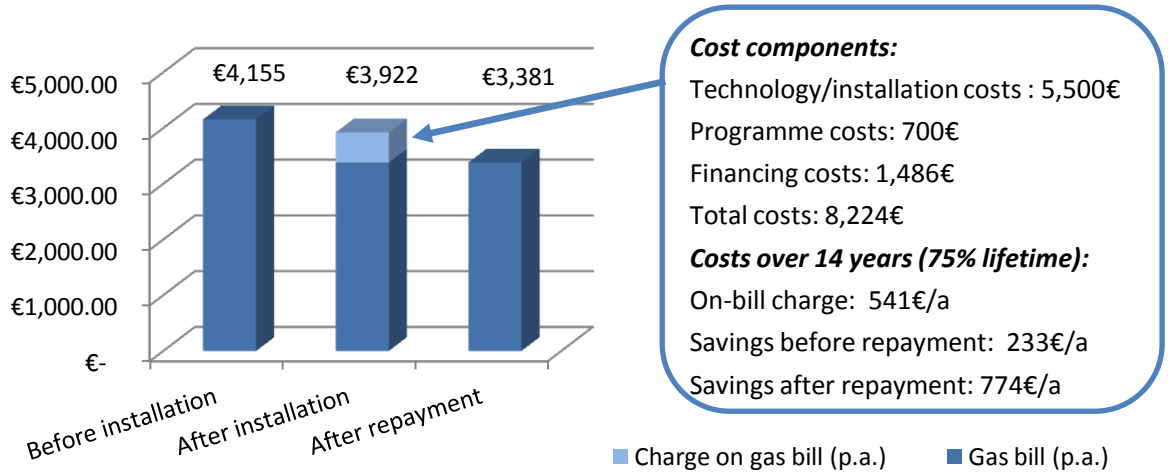

Figure 3 - Exemplary calculation for on-bill financing applied for a boiler exchange in a single-family home

Source: Own illustration; Data on costs and savings is based on BMVBS (BMVBS, 2012a)

For making the PAYS® system work, it is therefore a prerequisite that the measure's savings allow to pay-off the total costs, including costs for technology, the installation, administration, marketing, financing and further transaction costs. Limiting repayments to 75% of savings should ensure that the consumer benefits from immediate net savings after the installation of the measure(s). The customer enjoys the full savings after repayments have been settled. As the product is not designed as a loan, but as a utility service, consumers do not need to undergo a credit check. This reduces the hassle factor. If these conditions are fulfilled, the consumer has a strong incentive to say *yes* to the efficiency improvement (H. Lachman, personal communication, various occasions)

$M_2 \rightarrow B_2$ – *Lack of available capital and/ or liquidity preference:* Households tend to face difficulties or are reluctant to provide the capital for efficiency measures from their own pocket (Berlo et al., 2011; Guertler & Royston, 2013; Sanstad & Howarth, 1994). Under PAYS® this barrier is addressed, as consumers do not face the upfront costs related to energy efficient renovations. Investment costs are borne by the utility or third-party lender. The provider might finance the renovation from its own budget or seek external funding. From a consumer perspective, the OBF design has the advantage that outstanding service charges are not considered as debt. Therefore, OBF has no impact on the ability to access credit for other purposes or mortgage financing. This is also highly relevant for businesses that are often reluctant to take on debt on their balance sheets (H. Lachman, personal communication, July 8, 2014).

$M_3 \rightarrow B_3$ – *Split incentives:* The "split incentive dilemma", also called the "investor-user dilemma", describes the situation where the landlord (the investor) bears the costs, but the tenant (the user) enjoys a lower energy bill. As costs and benefits are split between the two parties, the landlord has no incentive to invest in energy efficiency measures, except the increasing value of the property. As most owners fear that property markets tend to undervalue the efficiency improvement, this incentive is usually not sufficient to trigger energy efficiency investments (Guertler & Royston, 2013; Jaffe & Stavins, 1994; Tuominen et al., 2012). This barrier is addressed by the PAYS® system, as the up-front costs are not borne by the landlord, but the utility or a third-party. It is one of the basic rules that repayments are borne by the beneficiary of reduced energy costs. Through the introduction of a charge on the energy bill the financial responsibility is shifted from the landlord to the tenant, given that the tenant is the bill payer and enjoys the benefits of the installed measure(s). In well-functioning property markets the landlord should benefit from an increased property value (Burr, 2013).

$M_4 \rightarrow B_4$ – *Uncertainty regarding long pay-back periods*: Investments in energy efficiency measures are by nature highly illiquid and mostly irreversible (Jaffe & Stavins, 1994). Combined with pay-back periods for deeper building retrofits of more than thirty years many consumers are reluctant to invest in efficiency improvements (Guertler & Royston, 2013). Under PAYS®, parts of the benefits are shifted from long-term future savings to the present. Due to the 75% rule, consumers should see an immediate benefit from a reduced energy bill even before investments are amortised. Furthermore, the payment obligation is connected to the gas or electricity meter, not to a legal person. This ensures that the actual beneficiary of the savings pays back the measure's costs. If the first programme participant moves out, the following resident is responsible for paying the outstanding charges. This overcomes uncertainties with regards to long pay-back periods (H. Lachman, personal communication, July 8, 2014).

$M_5 \rightarrow B_5$ – *Risk aversion:* As many efficiency measures are characterised by high-up front costs and long amortisation periods, consumers might face a significant loss if the measure breaks or does not yield the expected energy savings (Gates, 1983). The perception of high risks is translated into high discount rates for future savings that inhibit the introduction of efficiency improvements (Jaffe & Stavins, 1994). To overcome consumers' risk aversion, the PAYS®

system provides programme participants with a high level of consumer protection. The system mandates that if a measure breaks or fails the consumer's payment obligation has to stop. Only when the measure has been repaired repayments may continue. Limiting payback periods to 75% of the expected lifetime of the installed measure is another safety provision. Furthermore, the utility acts as a mediator between contractors, e.g. craftsmen, and consumers and thereby gives consumer complaints a stronger voice (H. Lachman, personal communication, July 8, 2014).

$M_6 \rightarrow B_6$ – *High transaction costs:* Transaction costs related to the installation of energy efficiency measures from a consumer's perspective are mostly related to the search of information about energy saving potentials, technologies and market conditions as well as the decision-making and contract negotiations with the energy efficiency service provider (Björkqvist & Wene, 1993; Gates, 1983; Jaffe & Stavins, 1994). Under PAYS®, the costs for searching information should be reduced, as the utility or certified contractors provide the consumer with the know-how about energy savings and technologies' characteristics. Based on an assessment of energy saving potentials in the customer's property, the consumer is approached with a tailor-made offer for installing and financing the recommended measure(s). Even though transaction costs on the customer side cannot be eliminated, they should be lower compared to most self-organised efficiency improvements.

Furthermore, it is not only the consumers' uptake of energy efficiency measures that is hindered by a number of barriers. The basic prerequisite for the PAYS® intervention theory to translate into practice is that energy service providers are able to yield energy efficiency potentials cost-effectively. Providers also face two major barriers, which are addressed by the PAYS® model:

$M_7 \rightarrow B_6$ – *High administrative and transaction costs*: Searching for information, marketing, due diligence, contract negotiations, programme administration, monitoring of energy use and cost savings are all sources of transaction costs on the provider's side that can move apparently cost-effective energy savings into the non-economic zone (Kiss, 2013; Mundaca, Mansoz, Neij, & Timilsina, 2013). Due to the small size of energy efficiency projects in households, transaction costs are regarded as relatively high compared to the overall investment (Guertler & Royston, 2013). The scale of these costs should be reduced by the simple and streamlined design of PAYS® programmes. As the finance provided is not designed as a loan, but as a service the time spent by the utility on credit assessments and contract negotiation should be reduced.

$M_8 \rightarrow B_8$ – *High finance costs:* Providing energy efficiency services at no up-front costs and spreading the repayments over a long period is still a novel concept for many banks. The (perceived) risk attached to this finance model is a crucial factor for banks when determining the appropriate interest level (K. Neale, personal communication, August 5, 2014). Therefore, utilities or third parties might struggle to access low cost finance (Guertler & Royston, 2013). Under the PAYS® system, the risk for the lender is reduced as the utility guarantees to repay the loan independent from customers' repayments. Therefore, it is the utility that is responsible for collecting repayments and outstanding debt from customers, not the bank. In case of non-payment the utility has the right to react with a disconnection of utility services (EEI, 2014). This creates a strong incentive for the customer to repay the costs, resulting in a low rate of defaulting customers. Tying the payment obligation to the building's electricity or gas meter is further a strategy of "de-risking" the investment from the side of the utility, as new residents can be held liable for outstanding charges (Bell et al., 2011; Cillo & Lachman, 2013).

4. Ex-post evaluation of on-bill programmes

4.1 The How$mart® programme in Kansas, U.S.

In the following sections the reader will be provided with background information regarding the introduction, the design and the performance of the How$mart® programme. Furthermore, it will be analysed how effective How$mart® is in overcoming the eight barriers, that should be addressed by the PAYS® intervention theory.

4.1.1 Context

Midwest Energy is a local electric and gas cooperative that serves 48,000 electric and 42,000 gas customers in central and western Kansas.[6] The introduction of How$mart® is based on long-term experiences with energy efficiency services, which have been promoted by the utility since the early 1980s as an effective tool to manage high bill complaints and to improve customer satisfaction (Volker & Johnson, 2008). Between 2005 and 2007, the City of Hays allocated higher than expected franchise tax revenues from Midwest Energy due to high gas prices. These revenues had the downside of increasing energy bills for Hays' residents. City administrators decided to use tax revenues for promoting the up-take of energy efficiency measures in low-income households. Midwest Energy got in charge of the energy audit programme. The utility realised that particularly lower-income households in rental properties were not able to implement the energy auditor's advice due to several market barriers, such as a lack of capital. Midwest Energy's aim was to provide a financing programme for efficiency improvements suitable for overcoming the identified barriers in rental and low-income markets. Midwest Energy learned about PAYS® and regarded it as an effective tool to address high up-front costs, capital constraints, long payback periods, conflicting incentives between landlords and tenants, and consumer education (Volker & Johnson, 2008). The PAYS® system, as it was designed by the EEI, built the foundation for the development of How$mart®. However, in certain aspects How$mart® deviates from the original design to better adapt to local circumstances. Therefore, Midwest Energy is not allowed to use the PAYS® trademark (Cillo & Lachman, 2013). The differences will be highlighted below.

Worldwide, Midwest was the first utility to voluntarily adopt the PAYS® system (Johnson et al., 2012). How$mart® was introduced as a pilot programme in 2007 in four counties. Initially, it was designed as an OBR programme. Midwest Energy lobbied at the state level for a change in legislation to allow the utility to restructure the financing from a loan to a tariff-based service. In August 2008, the desired legislative changes were in place and How$mart® was fully implemented in all 41 counties as an OBF model (Burr, 2013; Johnson et al., 2012).

4.1.2 Consumer uptake and installed energy efficiency measures

Until the end of 2012, Midwest Energy invested US$4.8 million in energy efficiency measures in 858 locations. By August 2014, 1,184 projects have been completed. Measures that are eligible under How$mart® must be permanently attached to the building. Portable measures, such as refrigerators, are thus not eligible under the programme (Johnson et al., 2012). Installed measures in the residential sector mostly comprise new heating systems. Other measures are the exchange of air conditioners, air sealing, insulation of the building shell and geothermal loop projects. The programme component How$mart Light® offers efficient

[6] Midwest Energy owns the electric transmission system. Electricity is generated from company-owned sources or procured contractually. The gas system is not vertically integrated. This means that Midwest Energy is not operating upstream transmission "pipes" or gas production facilities (Johnson et al., 2012; Volker & Johnson, 2008).

lighting solutions to the commercial and industrial sector. The average project size across all customer segments has been $7,489, based on data from 2012 (Cillo & Lachman, 2013).

Since inception, the energy efficiency measures installed under the How$mart programme saved 9,756 GJ of electricity and 33,072 GJ of gas. This resulted in 4,370 reduced tons of carbon emissions (Midwest Energy, personal communication, September 11, 2014). Midwest Energy closely monitored a small sample of households in the first year after the introduction of How$mart®. These households showed a 28% decrease in natural gas consumption in the winter months and a 15% decrease in summer electricity usage (Volker & Johnson, 2008).

4.1.3 The customer's journey under How$mart®

In the following section, the reader will be introduced to the How$mart® customers' journey, which comprises the key activities, transactions and contractual sequences that programme participants have to go through. It usually takes the following route: Some customers with energy bill concerns or complaints become familiar with the programme through contacting the utility. Others are actively approached by Midwest's contractors or informed about the programme by social service agencies when financing efficiency improvements from consumers' own means is not an option. When an initial contact has been established customers receive more detailed information about the functioning of How$mart® and a high-level screening of energy usage. This may then lead into a comprehensive on-site audit performed by one of Midwest's auditors. The audit may include the following services: an air infiltration test, an infrared scan, a duct leakage test and a furnace combustion test. Midwest Energy charges a fee of $200 if the customer decides to stop the process at this stage. In case the auditor cannot find improvements that result in a lower energy bill, Midwest Energy covers the costs and the process stops as well. If the audit reveals cost-effective energy efficiency potentials and the customer is still on-board, a preliminary Conservation Plan is developed which consists of recommended efficiency measures, the estimated costs of those measures and expected energy savings, translated into cost savings.

All measures are eligible where monthly charges for repaying the costs of the efficiency improvement do not exceed 90% of the yielded energy cost savings. Furthermore, the payback period is not allowed to exceed 15 years or 75% of the expected life of the measure. Particularly, costs of efficiency improvements in the building shell, e.g. a new façade, can be hard to unbundle from modernisation costs, which would have been borne by the property owner anyway. Under How$mart, there is no complicated procedure in place to differentiate between incremental and full costs of a measure. If savings allow for it, Midwest Energy bears the full costs of the measure (M. Volker, personal communication, July 2, 2014).

If the customer is interested in signing up for the programme, he or she solicits binding bids from a list of Midwest's approved contractors. When the most attractive bid has been chosen, the Conservation Plan is finalised (Johnson et al., 2012; Volker & Johnson, 2008).

In rental properties the landlord and the tenant must give their consent to participating in the How$mart® programme by signing a form. This form also requires the current property owner to inform new tenants or owners that a How$mart® payment obligation is tied to the building's gas or electricity meter (Johnson et al., 2012).

The customer informs Midwest Energy when the instalment of the chosen measure or package of measures has been satisfactorily completed. Midwest Energy carries out a post-retrofit audit to check if all measures have been implemented as prescribed in the conservation plan (M. Volker, personal communication, August 29, 2014). As a last step, Midwest Energy pays the contractor and starts to issue the monthly tariff on the customer's utility bill (Johnson

et al., 2012). The tariff is either allocated on the electricity or gas bill, depending on the customer's location in Midwest Energy's service area. While some customers only receive electricity, others are provided with gas or both, electricity and gas. However, in all service areas customers are eligible for measures that save electricity and gas. The payment streams under How$mart® are based on net utility bill savings, which are not necessarily Midwest Energy's utility bill savings (M. Volker, personal communication, May 27, 2014).

The steps of a customer's journey under How$mart® are illustrated in Figure 4. The blue arrows depict all kind of transactions. The yellow lines represent monetary flows.

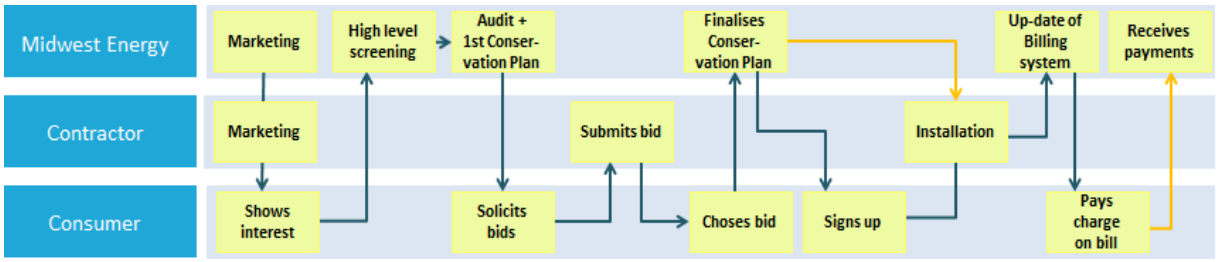

Figure 4 - Key activities and contractual sequences under the How$mart® customer's journey

Source: Own illustration based on (Burr, 2013; Johnson et al., 2012; Volker & Johnson, 2008)

As Midwest Energy does not operate in a liberalised market, there is no regulation in place for how to proceed with customers who wish to switch to another electricity or gas supplier (M. Volker personal communication, June 13, 2014).

4.1.4 Effectiveness in overcoming barriers on the consumer's side

As outlined before, the design of the How$mart® programme was inspired by the PAYS® system. In the following section it will be analysed how effective the How$mart® programme has been in translating the introduced PAYS® intervention theory into practice. Under each subsection a short summary will be provided if the programme was successful in introducing a mechanism for change (M_x) that is able to overcome the barrier under discussion.

4.1.4.1 Tackling inertia

As introduced above, consumers tend to respond to energy efficiency programmes with high levels of inertia (Krarup & Russell, 2005). Therefore, it is remarkable that, even though Midwest Energy does not provide additional incentives in form grants or rebates, about 55% of customers making decisions on projects agree to sign up for How$mart® (Cillo & Lachman, 2013). This means that the majority of customers being engaged with the programme regard it as a good deal. For those customers the hurdle of solving "complex optimization problems in order to obtain the least cost provision of energy services" (Sanstad & Howarth, 1994, p. 815) seems to be cleared. A major limitation is that the prerequisite of getting engaged with the programme is not fulfilled by the large majority of customers, as they are not actively approached by Midwest Energy, contractors or social service agencies. Customers with an above average energy use or unsatisfied customers are more likely to be informed about How$mart®. Out of the all customers 1.3% had participated within the first three years (Hayes et al., 2011), which means 0.43% of the total customer base have participated per year.

Effectiveness M_1: As the majority of customers who are actively approached under How$mart® say "yes" to efficiency improvements, high levels of inertia can be regarded as overcome without providing subsidies to trigger higher participation rates. A drawback is that only a small share of customers is actively targeted.

4.1.4.2 Tackling a lack of capital and/ or liquidity preference

Neither the building owner nor the tenant has to bear the up-front costs for installing the recommended measure(s), if savings allow for it. Here, the full costs are borne by Midwest Energy. The eligibility for participating in How$mart® is based on the identified energy saving potential. The utility checks the customer's utility billing history, but does not carry out a conventional credit assessment (Bell & Nadel, 2012). Therefore, How$mart® does not directly discriminate based on income. There might be an indirect discrimination as low-income households can be assumed to be likely in energy debt. However, for most households, How$mart® is overcoming the barrier "lack of capital" given that energy efficiency measures can be re-financed via the energy cost savings.

By limiting the monthly repayments to 90% of estimated energy cost savings, Midwest Energy provides customers with a 10% safety margin, in case savings realised are below expected savings. The margin is lower than the recommended 25% under PAYS®, but was chosen to allow for larger aggressive investments in efficiency measures (Volker & Johnson, 2008). This should not be misinterpreted that the 90% are always exploited to the fullest extent.

The question arises how to account for a potential rebound effect that partly or fully offsets the yielded energy savings. M. Volker (personal communication, June 13, 2014) reported a typical rebound effect of 25% after the installation of the energy efficiency measure, which is consistent with most estimates ranging from 15% to 30% in academic literature (Berkhout, Muskens, & Velthuijsen, 2000; Greening, Greene, & Di, 2000; Sorrell & Dimitropoulos, 2008). This means that households where the 90% have been fully exploited might pay higher energy bills over the payback period than before the measure's installation. The Citizens' Utility Ratepayer Board raised concerns that How$mart® might pose a risk to low-income households, as the utility has the right to disconnect the customer in case of non-payment (Burr, 2013). In contrast, Midwest Energy argues that How$mart® is decreasing the risk of disconnection as customers should enjoy lower utility bills even before the repayments are settled. The effect of "comfort taking" should not be accounted as "less savings" (M. Volker, personal communication, June 13, 2014). In summary, it is under debate how to account for a rebound effect and consequently if How$mart® programme participants risk to face higher utility bills. If customers pay higher bills than before the efficiency improvement, this has a negative effect on customer's liquidity, even if customers do not face any up-front costs.

The situation is different when customers wish to install measures where monthly repayments are expected to exceed 90% of the energy cost savings. Midwest Energy still bears the investment costs that can be recovered through 90% of the estimated cost savings, but customers provide additional funding from their own capital to bear the incremental costs. In these cases, investments in efficiency measures reduce the customer's liquidity in terms of net disposable income. M. Volker (personal communication, August 29, 2014) estimated that in about two thirds of all projects property owners or landlords have contributed to the financing of the measure. A capital injection from the customer is usually needed for replacing equipment related to heating, ventilation and air conditioning (HVAC), unless previously installed equipment has been very old and inefficient and great energy savings can be yielded after the exchange. Combining the exchange of HVAC equipment with highly cost-effective thermal insulations of the building shell is a common strategy to reduce the amount of capital required from programme participants. By the end of 2012, customers had invested US$1.4 million in addition to the US$4.8 million provided by Midwest Energy (Cillo & Lachman, 2013). Out of the total investments mobilised, customers' capital injection amounts to 22%.

Effectiveness M_2: How$mart® is overcoming the barrier "lack of finance" for households that are not in energy debt and that show saving potentials, where 90% of the savings over 75% of the measures' lifetime allow to

finance the total costs of the efficiency improvement. However, programme participants' liquidity might still be reduced when a rebound effect more than offsets energy savings and increases energy bills.

4.1.4.3 Tackling disincentives due to long pay-back periods

The risk of bearing the energy efficiency improvement's costs without seeing any benefits due to moving into another property before the end of the payback period is reduced significantly as the payment obligation ends with the end of the residence. Tying the payment obligation to the building's electricity of gas meter and not to the individual is a crucial element of How$mart®. It is fully in line with the design of PAYS®. However, this risk is only fully overcome for one third of the projects, where customers have not contributed any capital from their own pocket. Even before the end of the payback period, the energy user should enjoy lower energy costs due to the 90% rule. Seeing an immediate benefit can be regarded as a relevant incentive for customers with expected short residence durations.

The transfer of the payment obligation is ensured by different procedures. First, the property owner is obligated to inform a new owner or tenant about the How$mart charges. By signing a form, the owner agrees to pay the remaining balance of the How$mart® obligation within 30 days if the buyer was not notified before the sale of the property. Second, when moving customers call to close their billing accounts Midwest Energy reminds the owner of the agreed disclosure procedure. Midwest Energy also informs the new owner or tenant when the first contact is established for the payment of utility bills. However, this is usually taking place after the property has already been sold. Third, as Midwest Energy faced problems with owners, who did not notify the payment obligation correctly, the company adopted the policy of filing a commercial lien in form of a Uniform Commercial Codes (UCC) with the local County Register of Deeds. The property is then used as collateral to protect Midwest's interests. When a property title is searched, the How$mart® payment obligation will be recognized before the completion of the sale (Volker & Johnson, 2008). In this aspect, How$mart® deviates from PAYS®, where the property is not encumbered and the disclosure of the payment obligation is solely based on the contracts signed by programme participants (H. Lachman, personal communication, July 1, 2014). Midwest has also cooperated with local state realtors to depict How$mart® charges in "Seller Disclosure Forms" (Volker & Johnson, 2008).

Effectiveness M_3: As the payment obligation is tied to the energy meter, the risk to pay for improvements without seeing the benefit due to "long pay-back periods" is eliminated for those customers where measures are fully financed by Midwest Energy.

4.1.4.4 Tackling risk aversion

Unlike in the original PAYS® system, the utility does not take the risk for a failing measure. This risk is assigned to the property owner (Cillo & Lachman, 2013). Midwest Energy explains this deviation in the design of the How$mart® programme with interests expressed by local stakeholders. Customers as well as contractors preferred to have a close customer-contractor relationship without having Midwest Energy as an intermediary actor in case of problems with equipment maintenance (Burr, 2013). Nevertheless, Midwest Energy requires certain quality standards from contractors. For example, with regards to insulation materials blown in cellulose or foam are allowed, while fibreglass bats or blown in fibreglass is not (M. Volker, personal communication, June 13, 2014). Instead of using a formal accreditation system, Midwest Energy has been highly active in developing a strong relationship with contractors, e.g. by offering training opportunities on efficiency technologies (Volker & Johnson, 2008).

Effectiveness M_4: As the risk for a failing measure is borne by the customer and not by the utility, the barrier "risk aversion" cannot be regarded as overcome.

4.1.4.5 Tackling 'split incentives' between landlords and tenants

By shifting the payment obligation to the beneficiary of the energy cost savings, the "split incentives problem" between landlords and tenants has been overcome (Burr, 2013). Out of the total number of completed jobs, 14% were carried out in rental homes, which is consistent with the demographic characteristics of Midwest Energy's service area where 14.6% rent their homes (Johnson et al., 2012). For those measures where the costs cannot be fully recovered via the charge on the energy bill it, the landlord is required to provide capital in addition to the capital injected by Midwest Energy. In practice, tenants never bear any costs except the surcharge on the energy bill (M. Volker, personal communication, August 29, 2014).

As explained above, to create an incentive structure that appeals to both, the landlord and the tenant, it is essential that the payments and benefits are borne by the same actor. In the rental market under Midwest Energy's service area, there are different billing procedures in place:

(1) The tenant pays the utility bill. The landlord needs to give her consent, but is not involved in financing the energy efficiency measure, given that the measure can be fully financed via the energy cost savings. Here, the landlord only sees an indirect benefit in form of a quality improvement of the property. A service charge is attached to the rental unit's meter. The tenant bears the payment obligation and enjoys a lower energy bill after the installation of the efficiency measure. If the rental property is vacant it is the landlord's responsibility to pay the utility bill with the attached tariff. (M. Volker, personal communication, June 24, 2014).

(2) Energy costs are included in the rent. Based on consumption data from Midwest Energy the property manager calculates a utility cap, which is a flat utility fee, for the rental units. If the tenant consumes more energy than covered by the cap, he is responsible to pay additional charges. Here, the landlord is the main beneficiary of How$mart®, as the landlord does not pass on the energy cost savings to the tenant. The landlord pays the charge on the utility bill, but also enjoys the monetary savings and indirect benefits from an upgraded property. As costs and savings are borne by the landlord, there is no split incentives dilemma (Burr, 2013).

(3) Electricity is metered individually and paid by the tenant. Gas is not metered individually, but for the whole building, and is paid by the landlord. Here, the savings of the two energy carriers will be unbundled. The benefits as well as the charge for repaying measures that save electricity are located on the tenant's bill. The landlord is responsible for paying a charge on the gas bill, but also enjoys the cost savings related to the reduced gas consumption (M. Volker, personal communication, June 24, 2014).

As mentioned before, landlords should benefit from an increased property value due to efficiency improvements, even before the repayments have been settled. However, in practice owners were worried that a payment obligation tied to their property might be an obstacle for a property transfer. Midwest Energy learned that particularly landlords tend to frequently invest and divest in rental properties. As it was one of Midwest Energy's priorities to tear down barriers for the rental market, the utility dropped the policy of demanding an interest penalty for early payoff. This decision was already taken within the first year after the introduction of How$mart®. The new, more flexible design allows customers to pay off the outstanding balance at any time without facing penalties (Volker & Johnson, 2008).

Effectiveness M_5: As cost and benefits are always allocated with either the tenant or the landlord, the barrier "split-incentives" has been overcome in Midwest Energy's service area.

4.1.4.6 Tackling high transaction costs

There is no data available on TCs faced by How$mart® participants. Overall, the design of the programme has been kept relatively simple. As illustrated in section 4.1.3, customers have to go through five steps to receive an efficiency improvement financed by Midwest Energy. If the measure is fully financed by the utility, the customer only has to deal with two actors, Midwest Energy and the chosen contractor. If the customer chooses a measure where additional funding is needed and the customer is not able or willing to inject capital from her own pocket, a private bank might be involved in financing the improvement. As the utility takes over the work related to identifying energy saving potentials, calculating costs and benefits as well as seeking access to third-party finance, TCs are partly shifted to the utility, which would normally be faced by energy consumers when carrying out efficiency improvements on their own. From the literature review and interviews, no significant obstacles were found in the customer's journey. Therefore, it can be assumed that How$mart® participants face lower TCs than most non-participants who organise and implement the installation and financing of efficiency improvements in their properties themselves.

Effectiveness M_6: Due to the simple and streamlined design of How$mart®, resulting in a low number of contractual sequences and actors involved, it can be assumed that consumers face relatively low transaction costs.

4.1.5 Effectiveness in overcoming barriers on the provider's side

4.1.5.1 Analysis of administrative and transaction costs

As the programme operator, Midwest Energy faces several cost drivers that determine the overall level of programme costs. Major cost components are marketing costs, carrying out energy audits, administrative costs, such as the entry of How$mart charges into the billing system, and transaction costs that accrue from in-house capacity building, time spent on developing a contractor network, due diligence, or contract negotiations. Midwest Energy has no accounting system in place that allows for a breakdown of programme costs into specific cost components. By the end of 2012, programme fees amounted for US$ 207,000 (Cillo & Lachman, 2013). In relation to total investments made in energy efficiency technologies installed under the How$mart programme (US$4.8 million from Midwest Energy and US$ 1.4 million from programme participants), programme fees account for 3% of total capital costs. Spreading programme fees over the 858 sold energy efficiency service packages, programme fees amount to US$241 per project. Reported data from other PAYS programmes are located in a similar range (H. Lachman, personal communication, various occasions). Unfortunately, no quantitative data could be accessed to assess in more detail which costs are covered by programme fees. It is also unclear how well programme fees reflect rather "hidden" transaction costs, such as time spent on negotiating with the local state realtor organisation or preparing a workshop with contractors.

4.1.5.2 Financing costs

The utility succeeded in accessing low cost capital from different sources, such as the Kansas Housing Resources Corporation, stimulus funds through the "Efficiency Kansas" programme[7] and the Rural Economic Development Loan (REDL) from the U.S. Department of Agriculture (Cillo & Lachman, 2013). By mixing these sources of funding, the blended cost of capital is currently 2% (M. Volker, personal communication, May 27, 2014). This allows the company to pass on low interest rates to their customers.

[7] In 2010 and 2011 Midwest Energy received funding from the state's programme "Efficiency Kansas" that is fed by a revolving loan fund based on $37 million accessed through the American Recovery and Reinvestment Act (ARRA).

Interest rates[8] have ranged from 0 to 8% over the lifetime of the programme (Bell & Nadel, 2012). Over the last years, the interest rate for residential customers has been 3%. Commercial customers have paid a slightly higher interest rate of 4.5%. According to Michael Volker, the access to capital with low interest rates in the range of 2% is one of the key facilitating factors for a relatively high consumer up-take under How$mart®. Furthermore, the interest rate has an impact on the portfolio of measures that can be fully financed under How$mart. Lowering the interest by one percentage point allows an additional investment of $450 to pay-off over 75% of a standard measure. Therefore, financing costs have a direct impact on the eligibility of measures under How$mart (M. Volker, personal communication, various occasions).

It should be noted that Midwest Energy decided to lower the interest rate embedded in the programme costs to a rate below the allowed rate of return for the utility. The incoming money flow from programme participants does not fully recover the embedded costs of the programme. However, How$mart® is still regarded as a good sell for the company due to very high levels of customer satisfaction. As the preceding audit programme it is "seen as a customer service expense, not really a profit center" (M. Volker, personal communication, July 2, 2014). A survey customer satisfaction showed that customers who are aware of EES and who used the provided services show a higher level of satisfaction (see Figure 5).

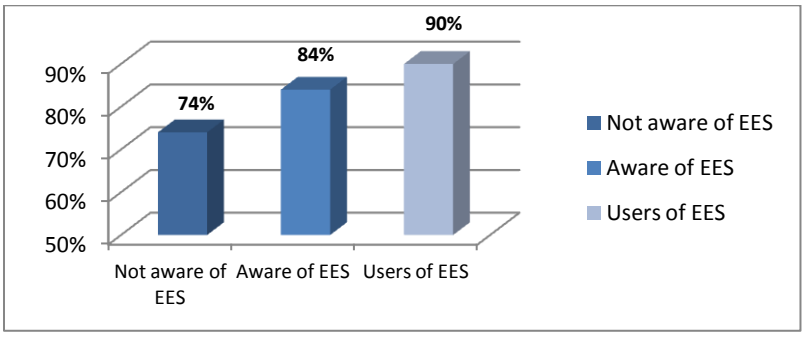

Figure 5 - Impact of energy efficiency services on Midwest Energy's customer satisfaction

Source: Own illustration based on Volker & Johnson, (2008)

Effectiveness M_8: Providing customers with a low-cost financing solution has a positive impact on the eligibility of energy efficiency measures under How$mart®. It can be regarded as a crucial facilitating factor.

4.2 Lessons learned and recommended policy design criteria

The How$mart® programme's design and performance raised a lot of interest. In Kentucky and South Carolina energy efficiency programmes were introduced that are based on the design of How$mart® (Burr, 2013). Which lessons can be learned from this case study and which policy design criteria can be identified for future on-bill programmes?

(1) Provide the installation and financing of energy efficiency measures as a service, not as a loan.

Providing the efficiency improvement as a utility service, not as a loan, is one of the essential design features of How$mart for increasing customers' willingness to participate in the programme. Paying a tariff based service on the energy bill, which is technically not taking out debt, is particularly attractive for consumers that are already in debt or simply risk averse.

[8] Note that there is a difference between the interest rate and the APR. The interest rate is "the proportion of a loan that is charged as interest to the borrower, typically expressed as an annual percentage of the loan outstanding" (Interest rate, n.d.). The "APR is made up of two components: [the] interest rate and any additional charges." (Zamarripa, 2014).

(2) By ensuring that the measure's beneficiary pays, OBF is able to overcome barriers in rental markets.

Midwest Energy's effort to create a programme design that overcomes barriers in the rental market has been successful (Burr, 2013). Providing the whole service, from the audit to the financing, at no upfront costs as well as allocating the payment of the tariff with the beneficiary of the energy cost savings, are two crucial elements for accessing the rental market.

(3) Require a margin between repayments and expected savings, to ensure customers see an immediate benefit.

Due to the 90% rule, How$mart® participants should see an immediate effect on their energy bill. Depending on the energy saving potential and saturation of energy demand, a rebound effect might reduce monetary savings in the range of 25%. However, increased comfort can also be regarded as an immediate indirect benefit to the customer.

(4) Seek sources of low cost capital that allow passing on low interest rates to programme participants.

Having access to low cost finance from the state enabled Midwest Energy to offer attractive financial conditions to their customers. As outlined before, low finance costs in the range of 3% p.a. increase the portfolio of measures that can be fully financed via energy cost savings.

(5) Place the utility at the centre of the programme to reduce administrative and transaction costs.

First, the utility has a direct relationship with its customers, which reduces transaction costs in several ways. Based on customer data, Midwest Energy can identify energy users who might be interested in participating in the programme due to high energy use levels or bill complaints. Furthermore, the new contractual relationship can be built on existing trust. The customer would not participate if the utility is known for its bad service and the utility would not provide financing for a customer who has an unreliable billing history (Bell et al., 2011). This reduces the need for additional checks, such as the customer's financial credit worthiness.

Second, tying the repayments to the energy bill reduces the risk of non-payment on the side of the financier. As the utility is able to react with a disconnection in case of non-payment, default rates across on-bill programmes in the U.S. are below 1% (Cillo & Lachman, 2013).

Third, the motivation of a utility is different from an independent ESCO. Creating a programme that recovers its costs is of course in the utility's interest. However, creating a programme that generates profit is not necessarily the first priority. In the case of Midwest Energy, the main motivation has been to raise the level of customer satisfaction. This is particularly interesting as Midwest Energy is not operating in a competitive market. In an open market, it can be assumed that utilities have an even higher interest in building a long-term relationship, even longer than an energy efficiency measure's payback period and in providing high quality services. As Johnson et al. (2012) explain: "From the utility's perspective, this is what makes How$mart® concept unique: it is not just an expense aimed at lessening the utility's sales volumes, but rather an investment that yields a rate of return like traditional utility investment while satisfying the same end-use need for the customer at lower cost. "

(6) Encourage utilities to establish a strong contractor network to avoid costly accreditation procedures.

Establishing a good contractor network through educational activities helped Midwest Energy to ensure that the implementation of efficiency improvements meets the desired quality standards. Contractors have an incentive to provide high quality products and services at relatively low costs to access the programme, as it can be regarded as a vibrant market place. Committed contractors also play an important role in promoting the programme.

4.3 The UK Green Deal

The following sections present background information on the introduction, the design and the performance of the Green Deal. To provide the reader with a good understanding of how the Green Deal's performance is influenced by the UK policy mix, two other sources of finance for energy efficiency measures that are closely intertwined with the Green Deal will be introduced. Based on this portray, it will be analysed how effective the Green Deal is in overcoming the eight barriers to efficiency improvements, as laid down in the intervention theory of PAYS®.

4.3.1 Context

The Green Deal was introduced as an energy efficiency financing programme against the background of three challenges: First, UK households "waste" £2 to 3 billion per year on energy costs due to poorly insulated homes and inefficient appliances (DECC, 2011b). Second, CO_2 emissions from the residential building sector are in conflict with national carbon budgets. For reaching a building sector wide 34% CO_2 emission reduction by 2022, emissions from residential buildings will need to be cut by 29% (DECC, 2010).[9] Third, the government needs to take action to reach its target to eradicate fuel poverty by 2016 in England and Scotland and by 2018 in Wales.[10] Energy efficiency improvements have been at levels far too low to overcome the identified social problems in the desired period of time (DECC, 2012). Policy-makers realised that by 2020 there would be saturation for low cost measures delivered by energy companies under the flagship instrument: the Carbon Emissions Reduction Target (CERT). Socialising costs of more costly measures on consumers' energy bills was regarded as politically unfeasible (Rosenow & Eyre, 2014). In times of short public budgets, it was therefore of key importance to draw in private capital into the energy efficiency market. The UK government assumed that high upfront costs paired with long payback periods and split incentives between landlords and tenants build two major barriers to privately financed energy efficiency improvements in the building sector. Against this background, the government intended to design an innovative, market-based instrument suitable for overcoming these barriers (DECC, 2010). According to a representative from DECC (personal communication, March 6, 2014) the development of the Green Deal was in part triggered by the UK Green Buildings Council report "Pay as You Save: financing low energy refurbishment in housing" (UK-GBC, 2009). The previous government under the Labour Party tested the concept in a pilot programme from November 2009 to July 2011 (Rosenow, Eyre, Rohde, & Bürger, 2013). It should be noted that the design of the PAYS pilots is not consistent with the original PAYS® system developed by the EEI. For example, there was no provision that estimated energy cost savings have to exceed repayments. Under the pilot programme households were provided with up to £20,000 per property at a 0% interest rate (Rosenow et al., 2013).

[9] The UK Climate Change Act introduced an overall carbon budget of 3018 Mt CO_2e for 2008 to 2012, 2782 Mt CO_2e for 2013-2017 and 2544 Mt CO_2e for 2018-2022. This translates into a 21% CO_2 emissions reduction by 2008 and a 34% reduction by 2022, compared to 1990 levels (DECC, 2010). High CO_2 emissions in buildings are largely related to the combustion of fossil fuels for space heating. Heating rooms and water with gas-fired boilers is responsible for three fourths of British households' energy consumption (DECC, 2010). In 2011, 59% of homes with cavity walls, but only 1% with solid walls had an insulation measure installed (DECC, 2011a).

[10] Households are considered to be in fuel poverty when they face fuel costs that are above the national median level and when they are left with a residual income below the official poverty line after paying these fuel costs. According to official statistics, 2.39 million households live in fuel poverty in England (DECC, 2013). The World Health Organisation (WHO Europe, 2011) estimates that cold housing caused 9,532 deaths per year between 1991 and 2005. Particularly, older people face a higher risk of fuel poverty. According to data from the National Health Service (NHS, 2013), two thirds of people with diagnosed hypothermia are older than 60 years .

The preparation of a primary legislative proposal for introducing the Green Deal, the Energy Act, already dates back to the previous government. After national elections in 2010, the new coalition government continued to work on the legal framework, but enacted several changes. According to Zoe Leader from the WWF-UK (personal communication, March 6, 2014), large parts of the "regulatory sticks", which would have acted as demand drivers for efficiency measures, were removed from the early version of the legislative framework. For example, originally homeowners who expand their property would have been obliged to upgrade the rest of their property to the energy performance standards of the Buildings Regulation.

The government carried out preliminary research on consumer attitudes, which suggested that a lack of capital is households' main reason for not implementing efficiency measures. More than 50% of the respondents indicated that the innovative element of payments being attached to their energy bills would make them more likely to take up a Green Deal. Policy-makers concluded that the on-bill design could be a motivating factor for a significant share of households to install energy efficiency measures in their homes (DECC, 2011c). Furthermore, in 2011, a formal stakeholder consultation was carried out on the proposals for the introduction of the Green Deal and a new Energy Company Obligation (ECO), which received more than 600 written responses (DECC, 2011d, 2012d).

This preparatory phase was accompanied by great expectations. Chris Huhne, Secretary of State, declared that 100,000 jobs would be created in the Green Deal supply chain within five years (DECC, 2010). Greg Barker, the Minister for energy and climate change, announced the objective of 14 million refurbished homes under the Green Deal by 2020 and another 12 million by 2030 (DECC, 2011b). This would equal a refurbishment of 97% out of 26.7 million homes[11] within less than two decades (DECC, 2011a). Estimates for the required investment to reach this scale of ambition range from £7 to £11 billion per year (Holmes, 2011). The Impact Assessment for the Green Deal and the Energy Company Obligation, published in 2012, already lowered these high expectations. It predicted that the Green Deal would draw private finance into the energy efficiency market amounting to £300 million in the first year and exceeding £400 in the following five years, a small fraction of the original announcement (DECC, 2012a). While the initial idea underlying the Green Deal was to leverage large energy efficiency potentials without additional subsidies, the financial calculations carried out in the Impact Assessment showed that many energy efficiency measures cannot be financed under the Green Deal alone. Savings often do not suffice to pay back technology, installation, finance costs and additional programme fees within the measure's lifetime or max. 25 years. For example, only one third of the costs for £9,950 of a solid wall insulation could be provided by Green Deal finance over a payback period of 20 years (DECC, 2012a). Against this background it became clear that the Green Deal as new policy instrument is insufficient to deliver the scale of energy efficiency improvements desired by the UK government. Two additional sources of capital were introduced that should be blended with Green Deal finance. The first one is the Energy Company Obligation (ECO)[12], which will be presented in more detail in chapter 3.2.1. The second one is a subsidy programme, the Cashback Scheme, recently replaced by the Home Improvement Fund (HIF), which is illustrated in chapter 2.3.4.

Based on the Energy Act, which was passed in 2011, five Implementing Regulations were introduced that build the legislative framework of the Green Deal. Further details are laid

[11] There are 26.7 million homes in total, out of which 23.3 million dwellings have lofts, 18.8 million have cavity walls and 7.9 million have solid walls (DECC, 2011a).

[12] The legislative framework is the *Electricity and Gas (Energy Companies Obligation) Order 2012,* which was passed by Parliament on December 4, 2012 and will run until March 2015 (gov.uk, 2014c).

down in the Codes of Practice for Green Deal assessors, providers and installers as well as the Green Deal Arrangements Agreement between electricity suppliers, Green Deal providers and finance parties.[13] After a delay due to IT and other problems, the Green Deal was launched on 28 January 2013 in England and Wales and on 25 February 2013 in Scotland, as the Government's "flagship piece of legislation, which will deliver energy efficiency to homes and buildings" (Hough & White, 2014).[14]

At the of the process, the Green Deal was designed as an OBR model offered by accredited providers at commercial interest rates (Mallaburn & Eyre, 2014; Interviewee from DECC, personal communication, June 18, 2014). A core feature is the Golden Rule: the expected energy cost savings must be equal to or greater than the Green Deal repayments attached to the energy bill. This principle naturally sets the upper limit for Green Deal finance available for the installation of energy efficiency measures (DECC, 2012d, pp. 16–17). As under PAYS® energy savings are not guaranteed, but are estimated based on average energy use. Repayments are allowed to equal 100% of the savings and to increase by 2% per year (DECC, 2012d). Even though the policy allows for a 2% escalator, it has not been applied yet (Interviewee from GDFC, personal communication, September 3, 2014). The underlying idea of allowing repayments to offset 100% of the savings has been to increase the available amount of Green Deal finance and therefore to increase the eligibility of measures with relatively higher costs and lower savings (DECC, 2010, 2012a). In contrast, under PAYS® available finance is limited to 75% of the savings and under How$mart® to 90% (Cillo & Lachman, 2013; Johnson et al., 2012). As under How$mart®, the Green Deal policy does not require that installed measures can be financed entirely through energy savings. The Golden Rule only sets the limit for available Green Deal finance. The customer can choose to seek additional sources of finance for less cost-effective measures (DECC, 2012d). In accordance with PAYS®, the financial responsibility is tied to the building's electricity meter, not to an individual.[15]

4.3.2 The Green Deal's interplay with the Energy Company Obligation

The UK has a long tradition of energy company obligation schemes to encourage the implementation of energy efficiency measures at the customer end. With the Supplier Obligation in 1994, the UK was the first European country that implemented such an instrument. Since then, numerous changes have been introduced. However, over the years the Energy Efficiency Commitment (EEC) and later on the Carbon Emissions Reduction Target (CERT) remained the most important policies to encourage energy savings and to reduce carbon emissions in the UK housing stock. The implicit annual energy savings target increased from 1.5 TWh in 1994-1998 to 104 TWh in 2008-2012. For an overview of the UK's history of energy company obligations see Rosenow & Eyre (2012) and Mallaburn & Eyre (2014).

The new ECO is covering all gas and electricity suppliers with more than 250,000 customers. Suppliers are not only obligated to yield energy savings at their customer end, but have to meet certain requirements regarding the type of measures installed and household segments. The rationale has been to provide funding for economically less attractive measures, as

[13] See The Green Deal Framework (Disclosure, Acknowledgement, Redress etc.) Regulations 2012.

[14] The five Implementing Regulations are: The Green Deal Framework (Disclosure, Acknowledgment, Redress etc.) Regulations 2012 SI 2012 No. 2079, The Green Deal (Energy Efficiency Improvements) Order 2012 SI 2012 No. 2106, The Green Deal (Qualifying Energy Improvements) Order 2012 SI 2012 No. 2105, The Green Deal (Acknowledgement) Regulations 2012 2012 No. 1660, The Green Deal (Disclosure) Regulations 2012 SI 2012 No. 1660.

[15] Establishing a legal foundation to tie the loan to the meter and automatically transferring it to new residents was a major challenge in the development of the Green Deal (Interviewee from DECC, personal communication, June 18, 2014).

insulating solid and hard-to-treat cavity walls (component 1), as well as to support vulnerable households (component 2 & 3). An overview over the specific requirements and targets for the three components can be found in Annex V. The costs borne by energy suppliers are spread over all energy bills regardless if customers have benefited from efficiency improvements or not (DECC, 2012a; Rosenow & Eyre, 2013; Rosenow & Galvin, 2013).

The introduction of the Green Deal and ECO turned the traditional aim of supplier obligations on its head. Now, the Green Deal is designed to draw in private finance for low-cost measures, while ECO is designed to provide additional funding for high-cost measures (Rosenow & Eyre, 2013). As companies try to maximise utility and therefore to minimise costs, suppliers used to focus on the most cost-effective measures under previous obligation schemes. As allowing the installation of cost-effective measures under ECO would undermine the delivery of Green Deal Plans, all measures that meet the Golden Rule are excluded from the first ECO component, the Carbon Saving Obligation (CERO). Green Deal providers, who act as the financiers to the final customer in the Green Deal supply chain, are able to access ECO funding either through bilateral contracts with obligated suppliers or through a brokerage platform.[16] Having access to ECO funding enables Green Deal providers to pass on subsidies to their customers for more costly measures (DECC, 2012a, 2014k). As stated above, the rationale behind this linkage was to achieve a blending of financing sources. However, in practice, providers reported that a blending of Green Deal finance with ECO subsidies has been relatively rare (DECC, 2014k). For accessing the ECO brokerage platform it is a prerequisite to be an accredited Green Deal provider. This policy design had the unwanted side effect that most companies went through the accreditation process without being interested in providing Green Deal finance plans. Many Green Deal providers used to deliver energy savings to energy suppliers under the EEC or CERT and regarded the ECO as a continuation of this market .[17] Other Green Deal providers who would be interested in a blending of ECO funding with Green Deal finance, but who entered the market over the last months, have not been able to access ECO funding (Green Deal provider, personal communication, June 16, 2014).

Even though the overall investments in energy efficiency improvements under ECO are comparable to the previous obligation schemes CERT and CESP with £1.3 billion per year (Mallaburn & Eyre, 2014), Rosenow and Eyre (2013) warned that yielded energy savings will decrease due to two effects: (1) the Green Deal is not expected to compensate a reduced installation rate of low-cost measures under ECO, (2) within ECO, the foregone energy savings from low-cost measures are not compensated by rising rates of high cost measures, such as solid wall insulations. This also affects carbon reduction levels. While the obligation schemes CERT and CESP resulted in CO_2 reductions of more than 60 million tonnes (Mt) per year, their successors Green Deal and ECO combined are expected to achieve roughly one fifth of this mitigation level, with 12.8 Mt of CO_2 per year (Rosenow & Eyre, 2013).

[16] On the brokerage platform, Green Deal providers can submit bids for selling energy savings to suppliers. Research on behalf of DECC showed that energy companies prefer bilateral contracts as a delivery mechanism for energy savings. The brokerage platform was regarded as a tool to fill shortfalls at attractive prices. Bilateral contracts were also regarded as more secure than buying savings from an anonymous party (DECC, 2014k). While prices for CSCO lots sold remained constant throughout 2013 at £50-£60 per tCO_2, prices under CERO showed a decreasing price trend from £110-£120 to £80-£100 per tCO_2. The buying price for lots sold fell from £0.22–£0.24 per £1 of lifetime cost savings in the first half of 2013 to £0.12-£0.14 per £1 of lifetime cost savings in the second half of the year. Both, providers and energy companies were sceptical that under current price levels energy savings could be delivered at an adequate quality (DECC, 2014k).

[17]. Other Green Deal providers are young start-ups, often with an engineering/ installation or financial services background. Other companies, such as installers of renewable energy systems, property maintenance and construction companies, as well as retailers and wholesalers and energy companies themselves, decided to extend their business area by becoming authorised Green Deal providers (DECC, 2014k).

DECC (2012) acknowledged the trade-off between achieving high levels of CO_2 reductions in the short-term and encouraging deeper refurbishments. Projections showed that including all kind of measures under CERO would yield 19% higher CO_2 reductions by March 2015.[18]

4.3.3 The Green Deal's interplay with the Cashback Scheme and the Home Improvement Fund

To increase the early up-take of energy efficiency measures, the government introduced the Cashback scheme for domestic customers in England and Wales. The scheme was provided with a capital injection of £40 million. From January 2013 to June 2014 grants of up to £4,000 have been distributed to households on a first come, first served basis. The prerequisite to be eligible for a Cashback voucher was to carry out a Green Deal assessment and to agree to a quote submitted by a provider. However, customers were not required to take out Green Deal finance to qualify for the grant (DECC, 2014g). In total, 16,438 Cashback vouchers were issued. The majority was used for boiler replacements (DECC, 2014e).

In June 2014, the Home Improvement Fund (HIF) replaced the Cashback scheme. The provided £50 million have been passed on to consumers in form of grants for energy efficiency measures. By combining a solid wall insulation with other efficiency measures households in England and Wales received up to £7,600. Due to an unexpected demand, the HIF was already closed for applications, two months after its introduction (DECC, 2014c). Additional funding up to £120 million should be made available soon (DECC, 2014a).

4.3.4 Consumer uptake and installed energy efficiency measures

The Green Deal is a young market-based instrument and it is too early to jump to conclusions about its performance. However, initial targets were clearly missed. By December 2013, only 1,612 households had signed up for a Green Deal financing plan (DECC, 2014d). Initially, Climate Change Minister Greg Barker had announced the target of 10,000 households taking out a Green Deal loan by the end of the year 2013 (Vern, 2014). For the first year, the Impact Assessment's central scenario projected the installation of 41,800 solid wall insulations and 398,000 cavity wall insulations under ECO and the Green Deal (DECC, 2012a). Installation numbers fell short of this projection with only 22,720 solid wall and 151,232 cavity wall insulations, representing a share of 54% and 38% of the desired outcome (DECC, 2014d). According to Steven Heath, Director for Public Affairs at Knauf Insulation Northern Europe (personal communication, March, 6, 2014), there is no significant market activity for insulation outside of these three schemes. Compared to previous years the total market activity has decreased from 1.6 million insulation measures installed in 2011 (loft, cavity and solid wall) to 300,000 in 2013 (DECC, 2011a, 2014d). Many market participants raised concerns about the negative impacts on the insulation industry (Harvey, 2013; Knauf Insulation, 2011).

By the end of June 2014, 263,068 Green Deal assessments had been carried out. Research carried out on behalf of DECC found that 44% of households who received a Green Deal assessment had installed at least one efficiency measure two to three months after the date of the assessment. However, the measures were not necessarily financed through a Green Deal. For 29% of the households, the up-front costs for the efficiency improvement have been covered completely by third parties, such as local authorities, housing associations, landlords or Green Deal Providers with access to ECO funding. Unfortunately, there is no data

[18] Easy-to-treat cavity wall insulations are the most cost-effective insulation measure with an installation cost of £500 and annual savings of £133. In theory, the installation pays off in less than four years. In comparison, solid wall insulation pays off after 36 years, without considering financing costs.

available on how many households installed measures with Green Deal finance as the only source of capital. Combined with Cashback vouchers, Green Deal finance was used by 5% of all households and combined with other sources by another 4%. About 7% fully financed the recommended measure(s) from their own pocket (DECC, 2014f).[19] Figure 6 illustrates how measures were paid for.

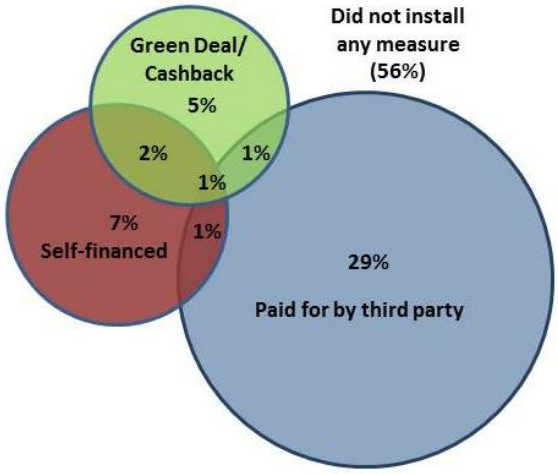

Figure 6 - Households' post assessment activity and sources of finance

Own illustration based on DECC (2014e)

By the end of June 2014, out of all assessed households, 1.2% (3,234) decided to sign up for a Green Deal financing plan. In 1,587 unique properties Green Deal plans have gone "live", which means that all measures are installed and payments are issued.

In total, 3,685 measures were installed using Green Deal finance. This shows that households tend to install one measure, instead of the envisaged packages of measures. The most popular measures have been photovoltaic systems, condensing gas boilers and solid wall insulations (DECC, 2014e). An overview over the type of measures installed is presented in Figure 7.

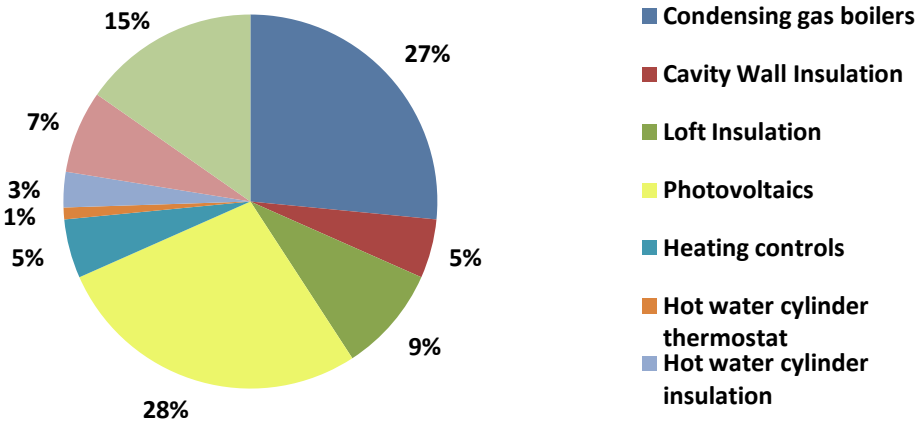

Figure 7 - Type of measures installed under the Green Deal

Source: Own illustration based on DECC (2014d)

[19] These shares are based on surveys sent out in three waves on behalf of DECC between April and December 2013 (DECC, 2014f). More recent waves of research do not provide data on the blending of different sources of finance (DECC, 2014i).

4.3.5 The customer's journey under the Green Deal

A normal customer's journey, in terms of key activities and contractual sequences, under the Green Deal comprises the following steps: The marketing of a Green Deal provider, assessor or installer, or any other type of information provokes a customer's interest in the Green Deal. Based on the acquired information, the customer chooses one of the certified Green Deal assessors who carries out an in-house energy audit and advises the customer on measure(s) that could be installed cost-effectively. The assessor is only allowed to recommend products from the Green Deal Measures List. [20] Eligible measures range from insulating the building shell, over hot water controls, to replacing fossil fuel based heating systems with renewable energy systems (DECC, 2014j). The list is regularly updated by the government.[21]

The assessor is required to state the results of the audit in a Green Deal advice report, which contains a Green Deal occupancy assessment, providing information on the householders' specific energy use, and an Energy Performance Certificate (EPC),[22] providing information on the physical dimensions of the building, the type of construction, the nature of the heating and ventilation systems, lighting and existing energy efficiency measures in place (DECC, 2012a).

With the Green Deal Advice Report the household approaches one or more Green Deal providers, who submit a quote, laying down the costs (investment costs, interest and further fees) as well as how these costs will be charged on the energy bill over a certain period of time. A common approach is that providers add their costs to the quotes provided by installers. These are then bundled together and offered to the potential customer (DECC, 2014k). To increase customer protection, for Green Deal Plans exceeding £10,000 customers are required to obtain at least three quotes from different providers (DECC, 2011c). When the customer decides on which company to work with, the provider starts to develop a detailed Green Deal finance plan, which is the contract between the Green Deal provider and the bill payer (DECC, 2012a). On behalf of the provider, the Green Deal Finance Company (GDFC), which acts as the lender to the provider, checks on the customer's credit worthiness. It comprises 1) a confirmation of the customer's credit rating; 2) checking the energy debt level of the customer (e.g. debt arrears); and 3) a check if the customer is a "politically exposed person" (PEP) as well as a sanctions check. In addition, the provider reviews the affordability for the customer (Interviewee from GDFC, personal communication, June 19, 2014). The amount of accessible Green Deal finance is limited by the Golden Rule. The repayments on the bill should not exceed the typical annual savings calculated for the measures.

When the homeowner, or in the rental sector the landlord and the tenant sign up to the Green Deal plan, the measure or package is implemented by an accredited installer. The installer is often the same company as the provider. Following the completion of the installation, the GDFC purchases the remittances of the Green Deal plan, meaning that the provider and

[20] For domestic properties, accredited assessors are required to use the "Reduced Data Standard Assessment Procedure" (RdSAP), which was developed by the Building Research Establishment (BRE) and is currently also used for generating Energy Performance Certificates (EPC). The methodology is based on the National Calculation Method as we all as standards set by the European Committee for Standardisation (CEN) and the International Organisation for Standardisation (ISO) (Booth & Choudhary, 2013). For non-domestic properties, the software tool "Simplified Building Energy Model" is applied, which has also been developed by the BRE Group (BRE, 2014; DECC, 2012d)

[21] The existing so-called "Appendix Q process" enables market participants to suggest new measures to be included in the list. DECC assists companies by covering parts of the costs related to the accreditation process (DECC, 2012d).

[22] The design of EPCs may differ from country to country according to regulatory requirements. In the UK, an EPC gives a property a rating from A, for the most efficient class, to G, for the least efficient class. The EPC is valid for ten years. In addition to information about a property's energy use and typical energy costs, it provides recommendations about how to reduce energy use and save money (gov.uk, 2014a)

installer are remunerated. The GDFC notifies the new Green Deal to the Green Deal Central Charges database run by Gemserv (Gemserv, 2014).[23] The GDFC also notifies the energy supplier, who receives 1p/plan/day or 2p/plan/day if it is a small provider as a compensation for the administrative burden (DECC, 2012a).[24] After the completed installation, the Green Deal Plan switches from 'pending' to 'live' and the energy supplier starts collecting repayments alongside the customer's usual electricity payment streams, which can be prepayment, daily, monthly or quarterly (DECC, 2010, 2012a). The energy provider forwards the payments to the Green Deal provider or directly to the GDFC, depending on the provider's preferences. As long as there are outstanding instalments, the energy supplier acts as a trustee for the relevant Green Deal provider and is responsible for collecting potential debt from the Green Deal participant. The energy supplier is obligated to use the same processes and efforts to recover Green Deal arrears as for electricity arrears, which means that non-payment may be responded with a disconnection of the customer from the supplier's services (DECC, 2012b). Default rates are expected to be low for this reason (Holmes, 2011). After the end of the payback period the GDFC settles the loan. The procedure is illustrated in Figure 8.

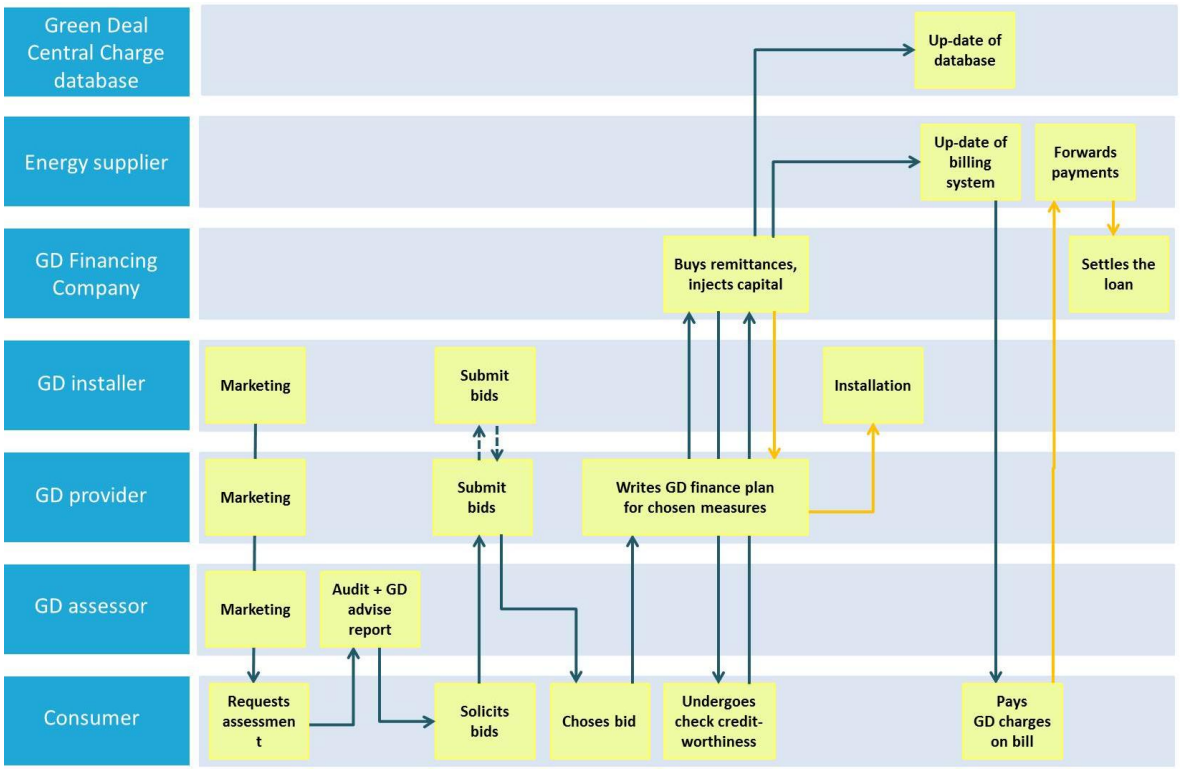

Figure 8 - Key activities and contractual sequences under the Green Deal customer's journey

Source: Own illustration based on DECC (2010, 2012a) and personal communications

[23] The government's decision to award Gemserv to become the "Green Deal Oversight and Registration Body" (GD ORB) and to run the Green Deal Central Charge database has been criticized. As the big six energy companies, British Gas, Scottish & Southern, ScottishPower, nPower, E.ON and EDF, are Gemserv's largest shareholders, the GD ORB might be biased against small companies, critics argued. The government defended its choice for being based on a competitive tendering process under EU procurement rules (ClickGreen, 2012).

[24] There is a levelisation mechanism in place to ensure that Green Deal providers do not pay more than 1p/day/plan. Therefore, larger suppliers receive slightly less to free up higher payments for smaller suppliers. These fees are invoiced every three months to reduce the administrative burden (DECC, 2012a)

The customer is still free to switch to a new energy supplier, even if the first supplier happens to be the Green Deal provider. The obligation to collect the outstanding Green Deal instalments on the customer's electricity bill is passed on to the new supplier (DECC, 2012a).

It should be noted that the actors and process steps included in Figure 8, only apply to successfully delivered Green Deal finance plans that are solely based on Green Deal finance. As already presented under chapter 2.3.4, many households decided to carry out a Green Deal assessment without signing up for a Green Deal finance plan, as the assessment is a prerequisite for being eligible for other sources of finance, such as ECO funding and Cashback/ HIF grants. As only a very limited number of measures can be financed with Green Deal finance alone, there will be very few cases where Green Deal finance has not been blended with funding from ECO, the HIF, the customer's own capital or third party financing, which might be provided by a private bank. It can be assumed that in the majority of cases more actors and steps are part of the customer's journey (DECC, 2014k).

In other cases, the customer might not be satisfied with the provided service and file a complaint. If the Green Deal provider, assessor or installer has not been able to resolve the complaint within eight weeks, the customer can access a dedicated Green Deal Ombudsman service (DECC, 2012a; gov.uk, 2014b).

4.3.6 Effectiveness in overcoming barriers on the consumer's side

In the following sections, it will be analysed how effective the Green Deal is in overcoming barriers that are addressed by the PAYS® intervention theory. Throughout the analysis, the differences between the Green Deal and the PAYS® system will be highlighted.

4.3.6.1 Tackling inertia

The UK government assumed that a lack of capital was the major barrier to energy efficiency improvements in the residential sector. As Gregor Barker explained: "We thought that unless we gave customers the payment method no one would touch these things" (Vern, 2014). As only 1.2% of households who received a Green Deal assessment, said *yes* to install a measure with Green Deal finance, it cannot be concluded that providing an OBR model has been effective an effective policy instrument for overcoming consumers' inertia. In relation to the total number of households, the Green Deal achieved a participation rate of only 0.006% in the first year.[25] Three out of four providers, who participated in the survey, reported that they regarded the "lack of interest or apathy of end-users" as a barrier for delivering Green Deals (Annex III). This disinterest in energy efficiency improvements is remarkable as households' annual electricity bills in England and Wales have increased by 170% and gas bills by 218% since reaching relatively low levels in 2004 (DECC, 2014b).

Research commissioned by DECC (2014k) found that providers mostly relied on their website and the database of the Green Deal Oversight and Registration Body and did not pursue direct-to-consumer marketing strategies. This means, the effort to establish a first contact between customers and Green Deal providers usually lies on the side of the consumer. None of the participating providers had carried out targeted marketing to approach customers that are more likely to proceed with a Green Deal plan, e.g. based on data on income or house types and energy usage. This finding was supported by interviews with Green Deal providers. As four out of five persons had not heard about at the Green Deal at its launch (Adam & Collinson, 2014), it is not surprising that relatively few customers have actively approached

[25] This is based on dividing 1,612 participating households over the total population of 26.7 million homes (DECC, 2011a).

assessors and providers. There seems to be a general miscommunication regarding who should be responsible for promoting the Green Deal. While the government intended to develop "a programme, which is owned by the industry" (G. Barker in webinar, Great British Refurb Campaign (2011)), market participants expected the government to promote the Green Deal more actively (Green Deal provider, personal communication, June 17, 2014).

Furthermore, against the background of a long history of energy company obligations, where many households received energy efficiency measures at reduced costs or no up-front costs (Rosenow, 2012), households might not have much appetite for bearing the full cost of efficiency measures (even though stretched over time). According to Zoe Leader (personal communication, March 6, 2014), the historical situation has lead to an underestimation of the real value of efficiency measures. Against this background it is unclear how the Green Deal is supposed to create demand. The interviewee concluded that for making the Green Deal work, a change in people's mindset would be needed combined with regulatory sticks.

The impact of the interest rate on consumer up-take is analysed in section 4.3.7.2.

Effectiveness M_1: The Green Deal has not been successful in overcoming consumers' inertia.

4.3.6.2 Tackling a lack of capital and/ or liquidity preference

As the Green Deal is designed as a loan, customers take out debt. This affects their credit record and might limit customers' ability to seek finance for other purposes (DECC, 2014k).

What has been achieved is that Green Deal finance is accessible to 83% of the population, while conventional finance is only available to roughly 50% (UK-GBC, 2014). The barrier "lack of available finance" has been eliminated for one third of all customers, but cannot be regarded as overcome. Even though the amount of available Green Deal finance is linked to energy savings, customers still need to undergo a check of credit worthiness and energy debt to be eligible for the Green Deal (DECC, 2014k). Therefore, there is still a discrimination based on income in place. This builds up a significant barrier for households that are already in fuel poverty and who are in the biggest need of efficiency improvements. According to Guertler (2012, p. 92), the Green Deal "on its own is not intended for alleviating fuel poverty, but rather focuses on 'able-to-pay' households." The government acknowledged this problem and introduced the Affordable Warmth (component 3 of the ECO), which has been designed as a complementary source of funding to target households in fuel poverty, who are neither able to finance efficiency improvements by own means, nor to access Green Deal finance (DECC, 2012a). However, Affordable Warmth replaced the previous government fuel poverty programme in England, the so-called Warm Front. In fact, the Association for the Conservation of Energy (ACE) calculated that the introduction of the Green Deal and ECO caused a reduction of available funding for households in fuel poverty by 29% (ACE, 2012).

Customers who have access to Green Deal finance still face the problem that there is often a funding shortfall for more costly measures and larger packages of energy efficiency improvements. Providers reported that Green Deal finance usually covers about one third of the total costs. Even where providers had access to ECO subsidies, these were often not sufficient to fill the financing gap. In this case, third-party financing from a bank or the customer's pocket is needed, which means that customers cover a share of the up-front costs with negative impacts on their liquidity in terms of disposable income (DECC, 2014k).

As in the U.S., critics in the UK expressed concerns that the Green Deal's major promise to enable households to yield energy savings at no costs, might not be fulfilled as estimated energy savings might not materialise due to false assumptions regarding the baseline energy demand, unexpected rebound effects or underperforming efficiency measures (Booth & Choudhary, 2013; Harvey, 2011). If the Green Deal assessor has demonstrably carried an

improper audit, he is required to pay an indemnity (Green Deal provider, personal communication, June 19, 2014). However, DECC acknowledged that there might be a significant disparity between theoretical and actual savings due to a number of other reasons, such as defective installations, obstruction to insulating parts of walls, natural variations in the thermal performance of structural and fabric elements as well as households failing to operate the measure correctly (DECC, 2012d). Detailed guidelines were published on the application of "in-use factors" to ensure more accurate estimates of savings related to measures available under the Green Deal. These factors limit the amount of Green Deal finance by a specified percentage, which ranges from 0% for solar water heating to 35% for cavity wall insulations (DECC, 2012c).

A potential overestimation of energy savings has been regarded as particularly problematic for households with a lower than average energy usage, which tend to be lower income households (Booth & Choudhary, 2013; Harvey, 2012). These households might not see the expected savings, as the Golden Rule is calculated based on data for average energy users. As repayments are allowed to amount for 100% of the savings (depending on the in-use factor for the specific measure) there is no general safety margin as under PAYS® where payments should not exceed 75% of cost savings. This risk is even higher in households that paid their reduced energy use with a loss of comfort and that are likely to adjust their indoor temperature to normal comfort levels after the efficiency improvement(s). For a measure with a high "in-use factor", such as 35% for cavity wall insulation, energy cost savings are likely to fully offset the Green Deal instalments with the effect of a lower energy bill. For other measures, such as solar water heating with a 0% in-use factor, repayments might easily exceed estimated energy cost savings. Here, customers might pay higher energy bills than before the installation. For customers that face difficulties in paying their utility bills, the risk might increase to be cut-off from utility service due to non-payment. The government responded to this concern related to "comfort taking" by requiring Green Deal providers to obtain a written acknowledgement from lower than average energy users, which states that the customer is aware of the Green Deal instalment potentially exceeding energy cost savings (DECC, 2012d).

Effectiveness M_2: As only a very small number of measures can be fully financed under the Green Deal, the barrier "access to finance and liquidity preference" has only been overcome for the most cost-effective measures. Furthermore, programme participation is based on income. The barrier prevails for low-income households.

4.3.6.3 Tackling long pay-back periods

As under PAYS®, payments are tied to the property, not to an individual person. To increase legal certainty, the Green Deal instalment is disclosed in the property's Energy Performance Certificate (EPC). Property owners need to order an EPC before marketing a property to sell or rent. Estate agents are also legally obliged to either disclose the EPC in full or the EPC property asset writing for a domestic property that is for sale (DECC, 2012a; gov.uk, 2014a).[26] Furthermore, the owner or landlord needs to obtain a written acknowledgement from the new resident stating that they are aware of the Green Deal instalment attached to the property and understand that they can be held liable, as the payment obligation is transferred to them. This acknowledgement may be included in contracts for sale, written leases and license agreements, or in standalone documents, where there is no written lease or licence agreement (DECC, 2011c).

[26] There are exceptions for buildings such as stand-alone buildings with total useful floor space of less than 50m², industrial sites, workshops and non-residential agricultural buildings with a low energy consumption or holiday accomodations. For a full list see gov.uk (2014a).

On the one hand, property owners as well as tenants do not face the risk to be liable for Green Deal instalments if they move out of the improved property. Unbundling the financial responsibility from the first Green Deal participant therefore reduces the uncertainty with regards to long pay-back periods. On the other hand, this barrier is only fully overcome for measures that are fully financed under the Green Deal and ECO, which is relatively rare. In most cases, where customer's used their own capital or loans from other banks, there is a risk investments might reveal themselves as a sunk cost. The customer might move out before seeing any monetary benefits. Theoretically, already before cost savings can be realised, property owners should see an indirect benefit through an increase of the property value. However, as there are no experiences made with selling properties with a Green Deal attached to it, many property owners fear that it might lower the property value in, as future buyers might be unwilling to buy a property with an unknown financial product attached to it (Interviewee from DECC, March 6, 2014). Originally, there has been an early repayment charge in place. As this was regarded as a barrier to the up-take of Green Deals, it was decided to allow for an early-payback without penalties (GDFC, 2014).

Due to the 100% repayment rule, households might only see a financial benefit from the Green Deal after the loan has been settled. Depending on the measure installed this may take up to 25 years. Therefore, even though the uncertainty regarding long pay-back periods is reduced, customers may not necessarily see immediate net savings on their energy bill. In this case, the incentive to participate is to see benefits in the long-term, which is not highly attractive if high implicit discount rates for future energy cost savings are applied by consumers (Gately, 1980; Hausman, 1979; Howarth & Sanstad, 1995).

Effectiveness M_3: The risk to pay for improvements without seeing the benefit due to "long pay-back periods" is only overcome for those measures that are fully financed under the Green Deal. This is very rare. The Green Deal does not require that customers see any immediate benefits. Savings may only materialise after the end of the payback period, providing little incentives to sign-up for an efficiency improvement under the Green Deal.

4.3.6.4 Tackling risk aversion

To ensure high levels of consumer protection, the government proposed that Green Deal products should be warranted for the entire repayment period.[27] This proposal was met with concerns from private companies. While such a guarantee could be provided for inert measures, such as insulations, costs would be prohibitively high for mechanical and electrical measures, for example it would almost double the cost of a boiler (DECC, 2012a). This motivated the government to limit the required guarantees to "five years and an extended 10 year guarantee to cover any consequential building damage sustained as a result of the measures being installed" (DECC, 2012d, p. 21).[28] As cost-effective guarantees for solid wall and cavity wall insulations have been already on the market, the required guarantee for improvements and consequential building damage is extended to 25 years for these measures.

Allowing payback periods for the whole lifetime of a measure as well as guarantees shorter than payback periods is not in line with the PAYS® system, as customers face the risk of paying for measures that are no longer working.

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[27] The warranty would have been required to be backed by an insurance and to be underwritten by an "A" rate company.

[28] Overall, the 10 year guarantee for the potential building damage was expected to increase the overall cost of a Green Deal package by 1% to 2.5%. It was hoped that Green Deal providers are able to reduce costs by negotiating extended warranties from manufacturers and installers. (DECC, 2012a).

Effectiveness M_4: By unbundling payback periods from product warranties, customers face the risk to pay for measures that do not deliver energy savings. The barrier "risk aversion" cannot be regarded as overcome.

4.3.6.5 Tackling 'split incentives' between landlords and tenants

As under PAYS® it is one of the key premises of the Green Deal that "those benefitting from the installation of a Green Deal measure should be the one paying the charge" (DECC, 2012d, p. 19). If energy costs are not included in the rent, it is the tenant who pays the Green Deal instalment and who also benefits from yielded savings. In theory, this should overcome the 'split incentives' barrier in the rental sector. Still, if usually only one third of the measures' costs can be covered by Green Deal finance it remains the question who pays for the remaining two thirds. According to the English Housing Survey, about half of private renters' length of residence is less than two years (DCLG, 2010). Under these circumstances, it is not attractive to invest in energy efficiency measures with long payback periods from a tenant's perspective. It is also unlikely that landlords are more willing to cover two thirds of the investment costs than before the introduction of the Green Deal, as they personally do not benefit from lower energy costs. Except for very few highly cost-effective measures where Green Deal finance can cover the total costs, such as the insulation of easy-to-treat cavity walls or the exchange of cylinder thermostats (DECC, 2012a), the old investor-user dilemma arises.

So far, there is no reliable data available on the performance of the Green Deal in the rental sector. Considering that less than 30% of households live in rented homes or apartments (Dieckhöner, 2012), the results from the survey suggest that the rental sector is not underrepresented. Three out of five providers reported that rental apartments accounted for a share higher than 25% out of all customers (see Annex III). However, these results are not statistically representative.

Effectiveness M_5: The barrier "split-incentives" is overcome where measure can be fully financed under the Green Deal. In practice, this is very rare and only feasible for the most cost-effective measures.

4.3.6.6 Tackling high transaction costs

Even though no quantitative analysis could be carried out of transaction costs faced by Green Deal participants, it can be assumed that these tend to be very high due to the large number of transactions and actors involved in the customer's journey. Consumers have to undergo a minimum of five steps to receive an active Green Deal Plan. As outlined above there is plenty of evidence that in practice further steps might be needed due to a shortfall of Green Deal finance and other obstacles, such as misinformation, need to be overcome (DECC, 2014k). Furthermore, the effort to establish the first contact is usually located on the consumer's side. Due to many Green Deal providers not being market ready and others working only with ECO funding, consumers reported that they had to call up to 20 providers until they found a company that was able and willing to work on their request (DECC, 2014k). This observation is supported by official figures from the GDFC (GDFC, 2014), stating that 38 Green Deal providers are actively selling plans, out of a 151 registered providers (DECC, 2014e).

Furthermore, when customers had chosen an independent Green Deal assessor, they often faced the problem that Green Deal providers were unwilling to use the produced advice report. Even though this is not in line with the Green Deal Code of Practice, many providers would not proceed with the development of a Green Deal plan. While some providers simply do not respond to enquiries from customers with advice reports from external assessors, other providers require the assessor to re-do elements of the report. The costs are usually covered by the provider, but consumers still face the hassle of another in-house visit (DECC, 2014k).

It can be observed, that instead of providing a streamlined procedure, a highly complex system has been created. The aim of developing a "one-stop-shop" model with "smooth transition between stages" (DECC, 2012d, p. 36) has not been successfully implemented into practice. Furthermore, by interlinking the Green Deal with ECO and Cashback, respectively the Home Improvement Fund, the customer is not interacting with one finance provider and one installer, as for example under How$mart®, but with up to five actors (the assessor, provider, installer, HIF and potentially a private bank). If a customer wishes or needs to blend Green Deal funding with Cashback and a private loan, he or she needs to undergo three different application procedures, which are related to significant levels of paper work. This complexity often provokes irritation on the customer's side, as many entered the Green Deal process with expectations raised by government advertising that energy efficiency measures would be fully financed under the Green Deal (DECC, 2014k).

Effectiveness M_6: Due to the complexity of the scheme, which is likely to result in a lot of time and effort invested in information seeking and application procedures, the barrier "high transaction costs" is not overcome from a customer's perspective.

4.3.7 Effectiveness in overcoming barriers on the provider's side

To overcome the barriers for the up-take of energy efficiency measures on the consumer's side, discussed under 2.3.6, it is a prerequisite that all actors in the Green Deal supply chain are able to fulfil their role in delivering the Green Deal as a final product. In practice, particularly Green Deal providers struggle to make a business case out of the Green Deal (Personal communication with various Green Deal providers, June 2014). Besides the general lack of demand, this is due to high administrative costs (ACs) and transaction costs (TCs) related to the provision of Green Deals. Furthermore, high financing costs have been identified as a major hindering factor. Current levels of APRs strictly limit the number of measures, where the total costs of a Green Deal Plan can be refinanced through the energy cost savings. Therefore, in the following two sections a closer analysis will be taken at the nature, scale and burden of transaction and administrative costs faced by Green Deal providers, as well as financing costs under the Green Deal framework.

4.3.7.1 Analysis of administrative and transaction costs

According to the conceptual choices, presented in chapter 2.2.1., transaction costs were defined as costs that are occurring *ex-ante* and *ex-post* of producing of Green Deal plans, the actual contract between Green Deal providers and their customers.

The survey results revealed that providers face several sources of TCs, such as in-house capacity building, accreditation costs, searching for information, interacting with the GDFC, customers, customers' energy suppliers and business partners. The finding that Green Deal providers regarded the interaction with customer's energy suppliers as a source of TCs is in conflict with the information provided by the GDFC that it is the GDFC who handles the notification procedure on behalf of Green Deal providers.

Interestingly project documentation and internal management, which can be regarded as an AC, was ranked as the top cost driver. The responses are illustrated in Figure 9. The differentiation of the scale of TCs and ACs (from very high to very low) is expressed in the colour coding and the order of cost drivers with the most significant cost drivers at the top. Other reported cost drivers that were not included in the questionnaire are IT development, lawyer's fees and travel costs.

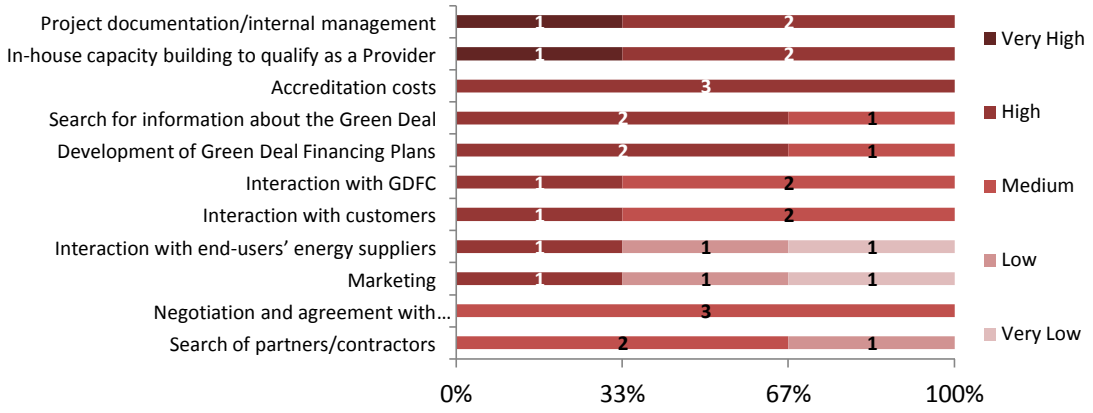

Figure 9 - Major cost drivers faced by Green Deal providers when selling Green Deal Plans

Source: Own illustration based survey results (see Annex II & III)

For the sake of clarity, it needs to be differentiated between the scale of TCs and ACs the burden of these costs for the individual provider. The scale may be a fixed or constant component, whereas the burden may decrease with the size of the project (Mundaca, 2007). Overall, the reported burden of running TCs in relation to total capital costs of all installed measure(s) ranges between 3% and 28%. ACs account for 17% to 75% and marketing costs for 0% to 36%. In all cases ACs exceed reported TCs. In three out of five cases aggregated ACs and TCs equal or exceed the investments made in technology and installation costs (see Figure 9). No reliable data could be gathered on the specific type of installed measures, such as cavity wall insulation. Most respondents indicated that investments in energy efficiency technologies exceeded investments in renewable energy installations (see Annex III). In the semi-structured interviews, providers were asked for the administrative costs related to the production of one Green Deal plan. Responses ranged between £300 and £450 (Green Deal providers, personal communication, various occasions).

It should be noted that the given responses revealed that providers applied different interpretations of the term total capital cost. Some providers reported only the capital invested via Green Deal finance, while others reported the capital invested from all sources of finance. All respondents were contacted and asked to review the provided data based on a clearer definition of total capital costs as the total amount of money that was invested into the measures under the Green Deal plans. This comprises total capital injected by the Green Deal provider through Green Deal finance or ECO, the consumer or grants from the Cashback scheme or the Home Improvement Fund. As providers write the Green Deal financing plan they should have a good overview over the sources of finance used for installing the chosen measure(s).

Face-to-face interviews with Green Deal providers revealed that the process of becoming a provider is a highly relevant cost driver. The accreditation process was often regarded as lengthy and complicated.[29] One provider reported that it was a highly time consuming process

[29] The official requirements are: "In order to operate as GD Providers, applicants are also required to: [1] Hold a Category A CCA licence, which enables them to lend money to consumers (the terms of GD Finance mean that the GD Provider is technically the lender). [2] Sign up to the Green Deal Arrangements Agreement (GDAA), which sets out the terms and conditions associated with the Green Deal Central Charge Database. [3] Obtain access to the Green Deal Central Charge Database (GDCC), which facilitates the collection (and remittance) of GD payments via the electricity meter. [4] Obtain access to the Energy Performance Certificate (EPC) Register, since GD Providers must update EPCs following the installation of measures under the GD. [5] Join the Green Deal Ombudsman and Investigation Service, which provides a redress scheme for consumers under the GD." (DECC, 2014k, p. 11)

with different forms going back and forth between his company and the accreditation body until they found that they mostly had to copy the Code of Practice into the application form (Green Deal provider, personal communication, June 17, 2014). With regards to the cost of working time spent on the accreditation process a second Green Deal provider estimated that a full-time employee was working on the accreditation for 5-6 months, costing the company between £15,000 and £20,000. On top, all providers need to pay between £15,000 and £20,000 in form of accreditation fees for the official accreditation process and the on-boarding with the GDFC. One provider indicated that additional £10,000 had to be spent on IT Software. Another provider estimated that, including opportunity costs[30], the process of becoming an active Green Deal provider cost the company £100,000 (Green Deal providers, personal communication, various occasions). Opportunity costs in this case can be defined as foregone income that could have been generated by choosing other business activities than engaging in the Green Deal market.

While some of the respondents had just started to sell the first Green Deal plans, others have been fully operational since 2013. This causes a bias in comparing TCs, including accreditation costs in relation to total capital costs. Younger Green Deal providers will automatically show higher TCs as accreditation costs are spread over a lower amount of invested capital due to a smaller number of Green Deal plans sold. Therefore, respondents were contacted again (same occasion as clarification on the definition of capital costs) and asked for a differentiation between accreditation costs and operational costs, comprised of ACs, TCs and marketing costs. Unfortunately, no clarification was received from provider 2 and 3. Overall, most providers had no accounting procedures in place for providing a quick overview over running TCs, ACs, and marketing costs in relation to total capital costs. Therefore, the illustrated data in Figure 10 and comparisons between the reported data should be treated with care.

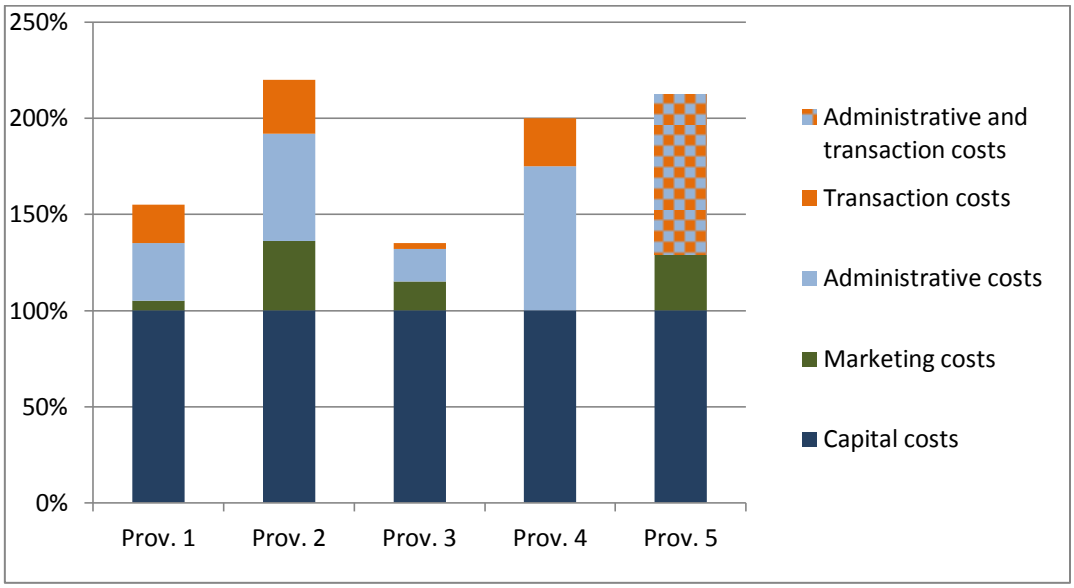

Figure 10 - Estimate of running marketing, administrative and transaction costs in relation to capital costs of all measures installed under Green Deal Plans provided by responding Green Deal providers

Source: Own illustration based survey results (see Annex II & III) and personal communications

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When adding accreditation costs of £45,000 (excluding opportunity costs) on top of running costs faced by two providers (those who reported absolute total capital costs, others only reported shares or highly aggregated data), ACs, TCs, marketing and accreditation costs account for 137% and 245% of total capital costs. Figure 11 illustrates how accreditation costs by far outweigh all other sources of costs that providers accounted for in their estimates.

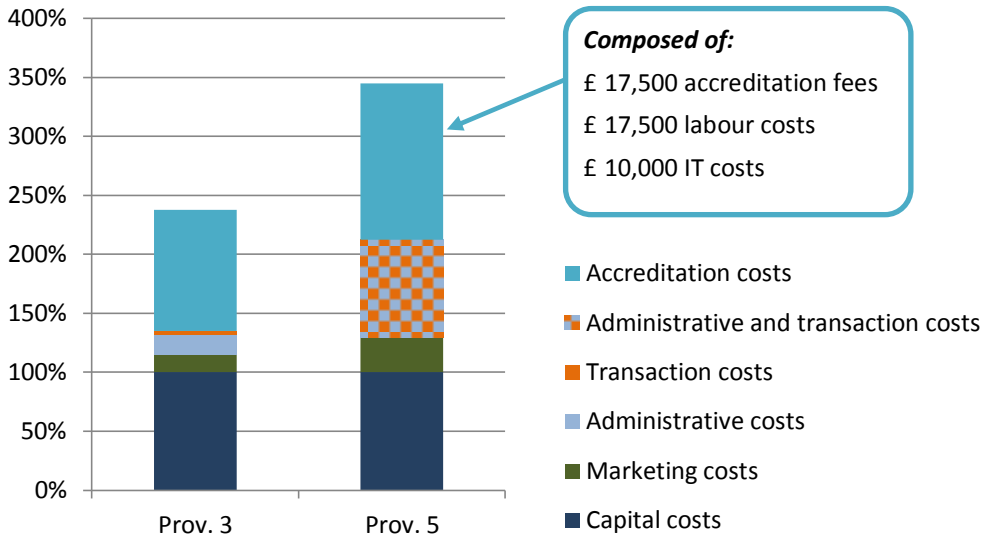

Figure 11 - Estimate of operational marketing, administrative and transaction costs as well as accreditation costs in relation to capital costs of all measures installed under Green Deal Plans sold by responding Green Deal providers

Source: Own illustration based survey results (see Annex II & III) and personal communications

Overall, most interviewed providers regarded the burden of ACs and TCs combined with a low demand from customers as too high to make an attractive business case out of selling Green Deal financing plans. One interviewee stated that if sales of Green Deal plans would not increase in the near future, the company would need to revise its business strategy. Another provider who recently got officially accredited feared that bearing another fee of £10,000 for on-boarding with the GDFC might not pay off, due to low consumer demand. However, as the provider had no access to alternative sources of finance, the completed accreditation would reveal itself as a major sunk cost. Accessing ECO funding at this point of time was also not regarded as unattractive as prices on the brokerage platform have decreased (Green Deal providers, personal communication, various occasions).

Effectiveness M_7: Aggregated administrative and transaction costs often equal or even exceed the technology and installation costs of the efficiency measures provided under the Green Deal. Many Green Deal Providers struggle to make a business case. The barrier high transaction costs can therefore be regarded as persistent.

4.3.7.2 Financing costs

One of the core assumptions underlying the design of the Green Deal was to provide access to capital to a wide spectrum of households through low-cost private finance (DECC, 2010). During the preparatory phase, the government actively engaged with banks to draw private finance into the Green Deal framework. This attempt was not successful. According to a former DECC employee, one of the major issues was where to locate the liability if the customer or the Green Deal provider defaults. In the end, banks regarded the Green Deal as an "untried scheme" with too many variables and therefore a hard to quantify risk attached to

it. The perceived high risk, as loans are likely to be passed on to new residents without requiring a credit assessment from these customers, would have resulted in very high interest rates attached to Green Deal loans (K. Neale, personal communication, June 24, 2014).

As banks were reluctant to engage with the Green Deal, two other options were considered. First, the government could have provided guaranteed loans to bring down the financing costs. However, this approach has not been politically feasible in times where reducing the state deficit had a high priority. Another option would have been to oblige energy suppliers to provide Green Deals to their customers and locating the liability on the supplier's side. While some energy suppliers saw the introduction of the Green Deal as an opportunity for opening new markets, other suppliers were reluctant to take on debt with negative impacts on their balance sheets (K. Neale, personal communication, June 24, 2014).

Against this background, a fourth approach was chosen. The GDFC was established as a not-for-profit mutual to finance and administer Green Deal Plans. It was provided with a capital injection of £244 million by the Green Investment Bank, DECC and 54 members from the public and private sector (DECC, 2014d; GDFC, 2014). In May 2013, the GDFC started to finance Green Deal Plans. It is not directly lending money to final consumers, but to Green Deal providers. As illustrated in the customer's journey, the GDFC buys the remittances for the financing plan from the Green Deal provider. The GDFC offers unsecured loans at a fixed interest rate of 6.96% for a lifetime of up to 25 years (GDFC, 2014).[31] Adding fees, e.g. for paying the provider, the APR is derived, which depends on the size of the loan. For smaller loans, in the region of £5,000 and below, providers reported APRs of 14-15%. The APR for larger loans, being worth more than £8,000, range between 8-10% (DECC, 2014k).

An analysis carried out by Capital Economics came to the conclusion that the interest rate is competitive when compared to other unsecured personal loans on the finance market (UK-GBC, 2014). Nevertheless, in a survey carried out on behalf of DECC, Green Deal providers regarded Green Deal finance for smaller loans as poor value for money (DECC, 2014k). This view has been supported by a representative from the insulation industry, as high-income households have access to finance at similar interest rates, but with higher flexibility on the High Street. Furthermore, many homeowners have the option to extend their mortgages and receive capital at an interest rate of 3-4% (S. Heath, personal communication, March 7, 2014). For this segment of households the economics of energy efficiency have not been improved.

The question remains how closely variations in the interest rate translate into consumer demand. A survey of 2,300 UK adults, conducted by the Great British Refurb Campaign (2011), found that 56% of respondents regarded the Green Deal as attractive. One third said to be "very" or "fairly" likely to take up a Green Deal with an interest rate of 2%. This share fell to 11% at a 4% interest rate and to only 7% at a 6% interest rate. It should be noted that research on consumer behaviour found a significant gap between statements and actions (Power & Mont, 2010). The up-take might be even lower than indicated by consumers.

What is puzzling is that the DECC Green Deal Assessment consumer research (2014) produced very different results. When participants were asked for reasons not to use Green Deal finance only 2-3% answered that it was not attractive. At least a partial explanation might be that 40% responded that they did not seek Green Deal finance, because the costs were covered by someone else. Again, this suggests that households sign up for Green Deal

[31] The Green Deal Finance Company has just launched a finance product for tenants. The impact has not been assessed yet.

assessments without being interested in a Green Deal plan, as assessments are a prerequisite to apply for the Cashback scheme. Overall, the government did not succeed in providing a financial product attractive enough to increase consumers' uptake of energy efficiency measures.

Independent from the level of the GDFC's interest rate in comparison to other financial products and with regards to consumers' attitudes, it has a clear impact on the number of measures that are able to meet the Golden Rule. For example, a hard-to-treat cavity wall insulation with installation costs of £1,875 and further costs for the Green Deal Plan of £400 would just be able to meet the Golden Rule at an interest rate of 3%, while it clearly doesn't at a rate of 6.96%. The insulation is yielding bill savings amounting to £133 in the first year. At an interest rate of 3% yearly instalments amount for £131 over 25 years, but at a rate of 6.96% instalments increase to £194.[32] In other words, an increase of the interest rate by one percentage point requires energy savings to increase by 10% for meeting the Golden Rule. This is roughly in line with the rule of thumb that a rise in the interest rate by one percentage point, requires energy demand to decrease by 7% to get the same amount of return reported by Steven Heath (in webinar of the Great British Refurb Campaign (2011)). While finance costs over the lifetime account for £991 in the 3% scenario, they rise to £2,588 under an interest rate of 7%, equaling 138% of the measure's initial installation costs.

This illustrates that the current interest rate has a significant impact on the range of measures which meet the Golden Rule and the overall attractiveness of the Green Deal. For many providers who do not have access to other means of funding, such as ECO or third party finance from private banks, this poses a major problem, as they are not able to deliver Green Deal plans without requiring their customers to cover a certain share of the up-front costs.

Effectiveness M_7: The current level of the interest rate limits the portfolio of efficiency measures that meet the Golden Rule. It therefore inhibits the delivery of Green Deal Plans. The barrier high financing costs is still persistent. The effect of the current interest rate on consumers' willingness to take-up Green Deals is debated.

4.4 Lessons learned and recommended policy design criteria

The Green Deal has been introduced with great expectations and a high level of interest in other European countries. One and a half years after its introduction, it is still early to evaluate the Green Deal. However, what can be observed is that households' uptake and numbers of installed measures are far from achieving initial targets (see section 4.3.4.). The barrier analysis showed that even though the terminology "Pay as You Save" is often used when referring to the Green Deal, the two systems differ in many crucial aspects. Overall, the Green Deal's design has not been able to fully overcome any of the barriers that should be addressed by the PAYS® intervention theory. So, which lessons can be learned for future improvements to the Green Deal and the introduction of similar programmes in other countries?

(1) Keep it simple – reduce transactions costs by limiting the number of actors and sources of funding.

Overall, interlinking the Green Deal with the ECO created a highly complex system with a number of undesired side effects. Seeing many Green Deal providers on the market that do

[32] This calculation is based on data taken from the Green Deal's Impact Assessment (DECC, 2012a, p. 138). It should be noted that there is a caveat to this calculation. It is not clear if in-use factors have been applied in the Impact Assessment. If in-use factors have not been applied, instalments certainly exceed the savings in both cases. It is also questionable if consumers are willing to take up a loan for such a long time period without seeing hardly any immediate savings. This calculation should therefore only be regarded as an illustration of finance costs' impact on total costs of a Green Deal plan.

not sell Green Deals is one of these effects. The complexity of the Green Deal due to the high number of actors and multiple sources of finance involved, translates into high administrative and transaction costs on the customer's as well as on the provider's side. By opening the Green Deal to many different actors, a robust accreditation system needed to be introduced. Here, the unwanted side effect was that the costs accruing during the accreditation process are so high that many small Green Deal providers risk going out of business. For future on-bill policies, it is essential to reflect the following trade-off: On the one hand, it is desirable to open the Green Deal market for small assessors and installers. On the other hand, placing energy suppliers at the heart of the Green Deal (and taking over the role of many small providers) could produce economies of scale and simplify the customer's journey, as fewer actors need to be involved.

(2) Seek sources of low cost capital that allow passing on low interest rates to programme participants.

The current level of the interest rate excludes measures from being financed under the Green Deal. There are different options to reduce the current level of the interest rate (UK-GBC, 2014). The government could provide the GDFC with access to low-cost capital. This allows providers to base Green Deal plans for highly cost-effective measures on one source of finance, the GDFC. Limiting the number of financing sources and therefore the number of actors and application procedures reduces overall ACs and TCs for providers and customers. For less cost-effective measures, ECO funding or grants from the HIF would still need to be accessed. However, to fully overcome the "high up-front" costs barrier, customers should not be required to provide additional capital on top of Green Deal and ECO or HIF finance.

(3) Require a margin between repayments and expected savings, to ensure customers see an immediate benefit

Allowing repayments on the energy bill to account for 100% of estimated savings, means that customers might not see any immediate net benefit (even without considering the rebound effect). Instead of applying "in-use" factors for specific measures, a general rule should be introduced that limits payments to a certain share of expected savings. Again, this would reduce the complexity of the scheme. Energy consumers could easily see that there is a safety margin that protects them from paying more than before the measure's installation.

(4) Establish a policy-framework that provides market actors with long-term certainty.

All respondents from the survey agreed that "uncertainty about the future development of the Green Deal" poses a barrier to their business models (see Annex III). During the first year of the Green Deal and ECO many conflicting signals were sent to market actors. How the government undermined the essential policy design criteria "long-term certainty" will be discussed in more detail in chapter 6.

(5) Ensure that all links in the supply chain are market-ready when introducing the programme

Already during the consultation phase, many market participants expressed the concern that the schedule for introducing the Green Deal is too ambitious. It was claimed that there was no transition period for the energy efficiency industry to change business models from delivering cavity wall insulations to delivering the high rate of solid wall insulations envisaged under ECO. Furthermore, only a small number of Green Deal providers were fully operational when the Green Deal was launched (DECC, 2012d; Great British Refurb Campaign, 2011). This led to a significant hassle for early-adopters trying to find a Green Deal provider that would deliver the energy efficiency service they requested. Providers reported that by the time they were able to deliver Green Deal Plans, the initial interest had dropped (DECC, 2014k).

4.5 Comparative Analysis of How$mart® and the Green Deal

How$mart® and the Green Deal were introduced with the similar underlying theory of making energy efficiency improvements available at no up-front costs and recovering the costs on the energy bill. Nevertheless, the analysis demonstrated that the programmes differ in many aspects, such as the nature of the financial product and repayment terms.

Overall, both programmes deviate from the original PAYS® system and the mechanisms introduced do not overcome all barriers as suggested by the PAYS® intervention theory laid down in chapter 3. One of the core assumptions underlying the development of PAYS® was to develop a system where customers are assured that they will only pay for the service if they personally benefit from the savings. As neither How$mart® nor the Green Deal provide warranties for the whole life time of installed measures, customers face the risk of paying for measures which are no longer working. This is a critical infringement of the PAYS® intervention theory where providing high level of consumer assurance is one of the key mechanisms to overcome risk aversion on the customer side (H. Lachman, personal communication, August 7, 2014). Core design features are summarised in Table 2.

Table 2 - Comparative analysis of How$mart® and the Green Deal

	How$mart® (Kansas, U.S.)	Green Deal (UK)
Nature	Utility initiative	Governmental initiative
Financing terms		
Financing costs	2% (0-8% APR)	6.95% (8-10% APR)
Access to subsidised loans from government	Yes (indirect)	No
Nature of product	Tariffed service	Loan
Repayment terms	Level: Max. 90% of savings Duration: max. over 75% of life time of measure	Level: Max. 100% of savings Duration: up to 100%% of life time of measure
Risk of non-payment	Utility (not lenders to Midwest Energy)	Green Deal Finance Company (lender to GD Providers)
Flexibility early pay-off	Without penalty	Without penalty
Transaction costs		
Programme	US$ 241 per service package	£350-400 per Green Deal plan
Economies of scale	One utility selling financing packages for many customers	(Ideally) high number of providers selling financing packages for many customers
Customer's journey		
Number of actors	2	3-5
Marketing	Targeted marketing, customers with complaints/ high bills	No targeted marketing
Audit	For free if customer signs up	Depending on provider, sometimes for free if consumer signs up for Green Deal Plan
Credit assessment	Billing history	Billing history, credit rating, PEP and sanctions check
Hassle factor for customer	Deals with utility and contractor	Deals with many actors, goes through significant paper work
Warranties	No warranties provided by utility	Warranties between 10-25 years depending on product
Provider's motivation	Customer satisfaction	Profit

Comparing the two programmes from a customer's perspective, it can be observed that the Green Deal is significantly more complex and requires much more commitment to go through the required process steps and to overcome the identified obstacles in the customer's journey. While Midwest Energy succeeded in developing a product where more than 55% of approached customers say *yes* to an efficiency improvement, only 1.2% of households who carried out a Green Deal assessment have decided to sign up for a Green Deal Plan. Interestingly, around 80% report that they have implemented at least one measure or are intending to install a measure, but seek other sources funding (DECC, 2014f, 2014h). This finding either suggests that a lack of access to capital is not a major barrier or that those customers who face this barrier do not even sign up for a Green Deal assessment.

From a provider's perspective, a similar observation can be made. Selling a Green Deal is much more complex due to its design as a loan, the number of actors involved and the detailed requirements set up by the government, above all regarding the accreditation process.

Nevertheless, it should be noted that in theory both programmes perform better in establishing mechanisms that overcome the identified barriers than they do in practice. A major a hindering factor is that many efficiency measures cannot be financed with OBF or OBR models alone, as energy cost savings do not allow to recover technology, installation, administrative, transaction and financing costs. The blending of capital with funding from the customer's own pocket or another bank lets the old barriers arise, as (B_2) customers might not be able to seek additional funding or have strong liquidity preferences, (B_3) face the risk of not seeing the benefits when moving out and (B_4) split incentives between landlords and tenants prevent investments in efficiency improvements. The analysis of new mechanisms introduced by How$mart® and the Green Deal and their effectiveness in overcoming identified barriers to the up-take of energy efficiency measures is summarised in Table 3. The green shading illustrates that a barrier can be regarded as "overcome", while yellow stands for "partially overcome" and red for "not overcome".

Table 3 - New mechanisms versus old barriers under How$mart® and the Green Deal

	How$mart®	Green Deal
B_1: Inertia	Once potential customer is reached, high participation rate	Even when potential customer is reached, low participation rate
B_2: Lack of available finance and/ or liquidity preferences	Overcome for customers that are not in energy debt with sufficient saving potential	Overcome for 83% of the population, but only for very few measures
B_3: Disincentives due to long pay-back periods	Overcome for highly cost-effective measures; limited where How$mart® finance is blended with customer's own capital	Overcome for highly cost-effective measures; limited in practice due to small number of measures that meet Golden Rule
B_4: Risk aversion	Not overcome	Not overcome
B_5: Split incentives	Overcome	Theoretically not overcome, empirically unclear
B_6: Transaction costs, customers	Relatively low	Relatively high to very high
B_7: Transaction costs, providers	Relatively low	Relatively high to very high
B_8: Financing costs	Low	High; competitive to other unsecured loans, but too high for many measures to meet Golden Rule

If three overarching lessons learned from the comparative analysis between How$mart® and the Green Deal had to be summarised for utilities and policy-makers that are interested in

introducing on-bill programmes, they would be the following key points. They will also lay the foundation for the ex-ante analysis of on-bill models for the German context (chapter 3).

(1) On-bill financing can be a suitable instrument to leverage investments in highly cost-effective energy efficiency measures. The economics of energy efficiency investments usually do not allow for deep retrofits to be financed under an on-bill programme. If savings allow to pay for technology, installation, financing, programme and other transaction costs, barriers on the consumer's side can be overcome, such as "lack of finance", "disincentives regarding long pay-back periods" and "split incentives" between investors and users. Attaching the payments to the property's electricity or gas meter is a unique feature of this innovative financing model which sets it apart from other financing offers such as conventional contracting.

(2) Within the different sub-categories of on-bill models, preference should be given to designing the product as a service (OBF) and not as a loan (OBR). Waiving credit assessments related to taking out a loan should reduce transaction costs on the customer's and the provider's side. It also tears down psychological barriers, as many consumers are reluctant to take on debt for investing in energy efficiency, even if their financial situation would allow for it (Stieß & Dunkelberg, 2013). Furthermore, basing the eligibility of programme participants on an assessment of energy saving potentials rather than a check of customers' economic status, improves the access to finance for energy efficiency improvements for lower income groups as well as small and middle enterprise who often struggle to access conventional capital markets.

(3) Placing the utility at the heart of the programme should reduce overall transaction costs for a number of reasons: (a) Existing data on energy use levels as well as communicating with unsatisfied customers allows for targeted marketing to customers where the largest energy savings can be yielded. (b) No new payment streams have to be established and no third actor has to be reimbursed for the administrative effort (as energy companies under the Green Deal). Charges on the energy bill can be incorporated in existing billing systems. (c) From the customer's perspective it reduces the complexity of the scheme as fewer actors are involved in the customer's journey. Furthermore, the utility acts as a strong intermediary in case of conflicts with the installer of an energy efficiency measure. In contrast, under the Green Deal the finance provider and installer is often the same company. (d) Last but not least, it should reduce transaction costs from the state's perspective, as quality assurance is largely left to the utility, which has an interest in achieving high levels of customer satisfaction through cooperating with highly-skilled contractors at the lowest possible price.

5. Ex-ante policy evaluation of promoting on-bill programmes in the German context

In this chapter, the lessons learned from the analysis of the How$mart® programme and the Green Deal, will be transferred to the German context. As laid down in chapter 2.3 the ex-ante evaluation of (a) policy instrument(s) that encourages on-bill financing is based on Mickwitz' (2003) six criteria: *relevance, impact, effectiveness, persistence, flexibility* and *predictability*.

5.1 Context - The German policy landscape for energy efficiency

The Energy Concept lays down the basic policy framework for the "Energy Transition" towards a largely carbon neutral energy system by 2050. It seeks to reduce Germany's total greenhouse gas emissions by 80% to 95% by mid-century. The "Energy Transition" is based on a large-scale shift to renewable energies as well as reduction in primary energy demand by 50%. The building sector plays a crucial role in reaching the overall energy efficiency and climate targets, as it currently accounts for 40% of Germany's final energy use and one third of total CO_2 emissions due to the combustion of fossil fuels for providing space heating, warm water, cooling and lighting (Becker et al., 2014). In the short term, by 2020, buildings' final energy demand for heating, cooling and warm water is aimed to be reduced by 20%. By 2050, primary energy demand should be lowered by 80%. The remaining energy demand should to be largely covered by renewable energies (BMWi & BMU, 2010). All energy efficiency targets (excluding transport) from the Energy Concept are summarised in Table 4.

Table 4 - Germany's national energy efficiency targets based on BMWi & BMU (2010)

	2020	2050
Primary energy demand (against 2008)	-20%	-50%
Increase in final energy productivity	2.1.% per year	
Electricity demand (against 2008)	-10%	-25%
Final energy demand in buildings for space heating, cooling, warm water	-20%	
Primary demand in buildings		-80%
Refurbishment of building stock	2% of total building stock per year	

While the Energy Concept builds the overarching framework for the German Energy Transition, the National Energy Efficiency Action Plans (NEEAPs) lay down more specific policy measures to reach the target of reducing the final energy demand by 9% by 2016 compared to the average final energy demand over the period 2001 to 2005. This target was defined by the EU Energy Service Directive (2006/32/EC, ESD). Two NEEAPs have been submitted in 2007 and 2011. The third one is currently under development (Bigalke et al., 2012; BMWi, 2007, 2011). The successor of the ESD, the Energy Efficiency Directive (2012/12/EU, EED) was adapted in May 2013 with the aim of reaching an indicative EU wide energy efficiency target of 20% by 2020. It requires all member states to reduce the national final energy use by 1.5%, measured in terms of sales of energy suppliers to final customers compared to the average sales from 2010 to 2012. For Germany, after accounting for all exemption clauses, this equals a reduction of final energy use of 1.125% per year or 73 PJ in 2014, accumulating to 512 PJ in 2020. Over the total time period, the cumulated final energy use needs to be reduced by 2.047 PJ (Dinges et al., 2014) .

Germany is expected to the reach the 9% target for 2016 (Bigalke et al., 2012). However, Germany will not fulfil the requirements of the EED without further action. There has been a methodological debate on how to accurately calculate the „implementation gap". Dinges et al. (2014) estimated that 502 PJ have to be reduced with additional actions. Furthermore, recent analyses show that Germany is not on track to meet its national energy efficiency targets. Current levels of an increase of 1.1% in final energy productivity per year need to be doubled, as well as current levels of the renovation rate of the building stock (Becker et al., 2014; BMWi, 2014; Löschel et al., 2014; Stieß & Dunkelberg, 2013; Weiss, Dunkelberg, & Vogelpohl, 2012). How the German government tries to encourage energy efficiency improvements will be illustrated in the following sections by introducing the reader to the existing policy mix comprised of regulatory, informational and economic instruments (see chapter 2 for a conceptual categorisation of policy instruments).

5.1.1 Regulatory instruments

Germany's major regulatory instrument for energy efficiency is the definition of minimum energy performance standards for buildings and energy consuming products. In light of the oil crisis and rising energy prices the first Energy Saving Act (EnEG) targeting the energy demand from buildings was introduced in 1977. The EnEG provides a legal foundation for several ordinances which lay down detailed performance standards. Compared to other EU member countries, Germany's energy savings regulations, dating back to the Thermal Insulation Ordinance (WSchVO), have been regarded as fairly progressive (IEA, 2013a; Weiss et al., 2012). Today, the Energy Conservation Ordinance (EnEV) builds the main regulatory law for energy efficiency in buildings. It defines minimum energy performance standards for the building shell as well as the heating system, ventilation, air conditioning and water boilers. Standards are split into classes for new and existing refurbished buildings.[33] However, only those efficiency improvements are mandated which are suitable for cost recovery (Weiss et al., 2012). In 2013, the EnEV was revised with the effect of an increase of efficiency requirements by 25% for new buildings from 2016 onwards (BMWi, 2014).

Another important regulatory instrument for the decarbonisation of the building stock is the Renewable Energies Heating Act (EEWärmeG), which was introduced in 2009. For new buildings, it requires a certain share of heating and cooling demand to be satisfied with renewable energy deployment (Weiss et al., 2012)

Moving away from the building sector to appliances, Germany has translated the EU Eco-Design Directive (2005/32/EC, respectively 2009/125/EC) into the Energy-related Products Act (EBPG, respectively EVPG). The Act defines environmental and efficiency standards for energy consuming products, such as cooling and freezing devices or office equipment.

5.1.2 Information instruments

There are numerous campaigns to educate energy consumers about energy saving potentials in their homes (see for example Co2online, 2014a, 2014b; GUSB21, 2014). Since the 1970s, consumer associations have played an important role in providing impartial consultations on energy efficiency improvements (IEA, 2013a).

In addition to campaigns for consumer education, the above presented regulations also mandate the provision of informational services. Since 1995, new buildings need to be

[33] EnEV performance standards for existing buildings need to be fulfilled "when 10% or more of the existing building component surface is changed or where more than 15m² of floor space is added" (IEA, 2013a, p. 42).

equipped with an EPC.[34] Since 2009, the EnEV also requires sellers, landlords or lessor to provide interested parties with an EPC to inform consumers about the energy demand of residential buildings (IEA, 2013a). Recently, energy efficiency classes on EPCs were introduced to increase transparency in the real estate market (BMWi, 2014; Weiss et al., 2012). A similar labelling approach is in place for energy consuming products. To better visualise the product's performance, efficiency classes from "A+++" to "G" have been introduced by the EU regulation 2010/30/EU.

5.1.3 Economic instruments

Economic instruments can be split into two categories. The first one is comprised of instruments that introduce economic disincentives for the usage of energy in general and the combustion of fossil fuels in more particular. The second category contains instruments that provide economic incentives with the aim of encouraging the up-take of efficiency measures.

Increased tax rates on petroleum, natural gas, heavy fuel oil and electricity, fall under the first category. These taxes were introduced in a step-wise approach under the Ecological Tax Reform dating back to 1999. Since then, several amendments have been enacted to the Energy Tax Act (EnergieStG) and the Electricity Tax Act (StromStG). To avoid negative effects on energy-producing and energy-consuming industries' international competitiveness, tax reliefs have been granted. Since 2013, these tax reliefs are linked to the implementation of energy management systems and an industry wide energy saving target (IEA, 2013a).

The major economic instrument falling under the second category is a large-scale soft loan programme for energy efficient refurbishments of existing homes and energy efficient new buildings. This instrument will be presented in more detail in the following section.

5.1.3.1.1 The KfW Programmes for Energy Efficient Refurbishments

The flagship instrument for energy efficient refurbishments in the German household sector is a preferential loan programme run by the state-owned development bank, Kreditanstalt für Wiederaufbau (KfW). The KfW CO_2-Building Rehabilitation Programme (CO_2 Gebäudesanierungsprogramm) was introduced in 2001. In 2009, it was replaced by the KfW Programmes for Energy Efficient Refurbishment and for Energy Efficiency Construction.

To be eligible for KfW funding it is mandatory to consult an accredited energy advisor from a database operated by the Germany Energy Agency (see: Dena, 2014).[35] Under the Efficient Refurbishment programme loans are granted to homeowners at a guaranteed interest of 1% for a term of ten years. The loan can be extended up to 30 years. There is a grace period between two and five years, where only interests have to be repaid, but not the loan itself (KfW, 2014c). The loan terms for refurbishments differ between two classes of loans. The first type of up to €50,000 per housing unit is available for single measures such as thermal insulation of walls, roofs, basements and floors, replacement of windows and exterior doors, renewal or optimization of the heating system and the renovation or installation of a ventilation system. In addition, indirect costs which are related to energy efficient refurbishments are covered, such as additional building costs (e.g. for an architect or building

[34] The EPC is must contain information on „the year of construction, use of the building, usable surface area, and type of heating, water heating, and type and percentage of renewable energies" (IEA, 2013a, p. 42). It also provides recommendations for efficiency improvements if cost-effective saving potentials have been identified.

[35] The most comprehensive standardized assessment is the so-called "BaFA-Vor-Ort-Beratung", where assessors are required to use certified computer software to develop tailor-made energy efficient refurbishment recommendations. The government subsidises the service with €300. Homeowners pay the remaining €300-400 (Stieß & Dunkelberg, 2013).

permits), building recovery costs (e.g. plastering walls after insulating) and costs for consulting, planning and other services during construction (KfW, 2014b). The second type of loan, of up to €75,000, can be combined with grants for more ambitious refurbishments which meet the KfW's "Efficient house" standards. The terms follow a basic rule: the more ambitious the refurbishment is the more attractive is the KfW financial package, comprising a low-interest loan and a grant. The reference point for the "Efficient House" classification is the German building code, specified in the EnEV. The "Efficient house" class 100 equals the energy efficiency requirements for new buildings. The EnEV allows refurbished existing buildings to exceed the minimum performance standards for new buildings by 40%. The KfW loans reward refurbishments that go below the mandated max. level of energy use. For example, a refurbished building that exceeds the energy use of new buildings by only 15% meets the KfW "Efficient house" 115 standard. There are four standards from 115 to 85 (KfW, 2014d).

For the constructing or purchasing buildings, the KfW offers loans of up to €50,000 to homeowners and contracting agents at an interest rate of 1.51% for a term of ten years. Again, the terms vary depending on the "Effcient House" standard reached after the efficiency improvement. The classes range from 70, 55, 40 to the passive house standard. For the most ambitious ones 55, 40 and passive houses, grants of up to €5,000 are issued (KfW, 2014a).

According to the International Energy Agency (IEA, 2013a, p. 41), the KfW Energy Efficiency Programmes can be regarded as "one of the most significant programmes worldwide in terms of ambition and amounts of finance available". Interestingly, the programmes saw a low demand during the first years. This changed when the KfW started to cooperate with local customer banks, who sell KfW loans to their final customers (D. Becker, personal communication, September 8, 2014).[36] Despite high levels of demand, the programmes have seen turbulent times due to an unsecure funding situation. Funding for the cross-subsidized interest rate and grants used to be provided by the national budget. In 2011, the programme started to be funded partly through the German Energy and Climate Fund (EKF) and in 2012 it has been solely based on the later one (IEA, 2013b). The EKF is largely dependent on the auctioning revenues from the EU Emission Trading System (ETS), which caused the EKF to run into financing problems when prices in the EU ETS dropped sharply.[37] The result were severe budget cuts for several climate and energy initiatives, including the KfW Programmes (Doelling, 2012). The programme's budget decreased from €2.25 billion in 2009 to €900 million in 2011 (DENEFF, 2011). Against this background, in March 2012, the parliament's budget committee decided to provide additional funding from the national budget, going back to the mixed public-private-financing model. Since then, the annual programme budget has been stabilised at €1.5 billion per year (KfW, 2013).

It should be noted that finance provided by the KfW is not the same as total investments made in energy efficiency improvements in buildings. The consultancy Prognos AG estimates that annual energy related investments in the building stock account for €4 billion per year under the current refurbishment activity level of 1% per year (Thamling & Kemmler, 2012).

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[36] Most conventional banks, such as Deutsche Bank, Sparkasse, Volks- und Raiffeisenbank, or Commerzbank offer the KfW financial products for energy efficient refurbishments. The loans are refinanced by the KfW while the customer banks receive a margin for credit risk handling (Dorendorf, 2013).

[37] The government had calculated with a price of EUR 17 per European Emission Allowances (EUAs), generating sufficient income to finance several subsidy-driven climate and energy initiatives, such as the KFW energy efficiency programmes or the International Climate Initiative (ICI). However, due to the oversupply of EUAs on the European ETS spot market, the price per certificate dropped to only EUR 7 in 2011, creating substantial financing shortages (DENEFF, 2011).

5.2 Evaluating the relevance of on-bill models

Which conclusions can be drawn regarding a potential introduction of on-bill programmes?

First, even if funding for the KfW programmes will be stabilised over the next years, additional sources of finance need to be tapped to reach the ambitious energy efficiency targets in the German Energy Concept. The German Institute for Economic Research (DIW Berlin) calculated that for doubling current refurbishment rates in residential buildings, additional energy related investments of €7.4 billion per year will be needed in 2020, increasing to €9 billion in 2030 and €14 billion in 2050.[38] In other areas additional €4.2 billion by 2020 and €4.7 billion will be needed, for example for the refurbishment of non-domestic buildings, the replacement of inefficient electric households appliances and efficiency measures in the commercial sector and industry (Blazejczak et al., 2014). These estimates involve a significant degree of uncertainty. Nevertheless, they illustrate that there is a need for accessing new and also private sources of finance. The German government acknowledged the challenge and decided to examine new market-based instruments (Becker et al., 2014). Against this background, the introduction of on-bill programmes can be regarded as *relevant*, if those programmes have access to private sources of finance or to public sources that are budget neutral, for example once a revolving loan fund has been established.

Second, while the EnEV defines minimum performance standards, the KfW programmes provide financial incentives for ambitious single measures and deep refurbishments that are not necessarily cost-effective from a household perspective (Rosenow et al., 2013). Currently, there is a significant gap in the policy mix to encourage the up-take of less ambitious, but highly cost-effective energy efficiency measures. While some energy providers and consumer associations handed out grants for yielding "low-hanging fruits" particularly in low-income households, no long-term policy instruments were identified that target energy efficiency measures in buildings which go beyond the minimum requirements laid down by the EnEV, but that do not qualify for the higher KfW standards. As on-bill programmes tend to focus on highly cost-effective measures which require relatively small investment volumes, they could be a highly interesting option to close this gap. Regarding the installed type of measures there might be a certain overlap as the KfW also provides finance for the exchange of heating systems. However, with regards to targeted consumer segments, research on consumer behaviour suggests that OBF programmes, which are designed as an energy efficiency service and not as a loan, could be appealing to consumers that do not engage with a loan programme. More than two-thirds out of a sample of 1,008 homeowners are unwilling to borrow money for financing (further) energy efficiency measures. This cannot be explained with the burden of already existing debt, as only slightly more than one third reported that the credit line for the property is exhausted. The authors conclude "that a negative attitude towards loans is a major barrier against a comprehensive refurbishment" (Zundel & Stieß, 2011, p. 98). Basing eligibility criteria on energy saving potentials, might also trigger modernisations in small and middle enterprises that are often not rated as credit worthy.

Furthermore, no national energy efficiency programmes that provide incentives for the replacement of old inefficient electronic devices were identified. This could also be an interesting area where on-bill models might have a significant *impact*. When applying on-bill models to portable measures the payment obligation should be tied to the programme participant, not to the building's electricity or gas meter (M. Volker, personal communication,

[38] Due to diminishing rates of return (yielded energy savings per €), energy related annual investments increase significantly over time. Blazejczak et al (2014) assumed energy related investments to account for 30% of the refurbishment's full costs.

September 2, 2014). If the person moves, repayments could be continued in a new location, given that the energy supplier is still active in this area. If the energy supplier is switched, the outstanding charges could be paid back early. As payback periods are usually much shorter and investments are much more liquid than investments in the building shell, the market barrier "uncertainty with regards to long pay-back periods" can be regarded as relatively low. In summary, OBF programmes should have an *impact* in form of an increased energy efficiency activity, alongside the improvements triggered by the existing instruments mix.

5.3 Evaluating the impact of on-bill programmes

Based on the premise that on-bill models might be an interesting complement to the existing energy efficiency policy mix, it is analysed what kind of energy saving potential in the residential and commercial sector could be addressed. Furthermore, it will be assessed which measures could be eligible under on-bill programmes to identify if these programmes might have a measurable *impact* alongside the existing policy mix.

5.3.1 Identification of unexploited energy saving potential

Several studies have been published on cost-effective energy saving potentials in the German residential and commercial sector (see: Dena, 2012; Pehnt et al., 2011; Schlomann, Becker, & Bürger, 2012; Seefeld et al., 2007). As applied methodological approaches differ significantly, the results cannot be directly compared. Projections from Pehnt et al. (2011) were used for further analyses as provided data allows for a relatively detailed breakdown of energy saving potentials in the residential and the commercial sector.[39] The authors established three scenarios: (1) a "frozen efficiency" scenario, assuming no further efficiency developments and a constant final energy use of 9000 PJ per year (2009 levels), (2) a reference scenario, extrapolating current trends, (3) an "ambitious efficiency" scenario, where the implementation of cost-effective efficiency measures is accelerated due to an optimal policy framework. When comparing the frozen efficiency scenario with the ambitious scenario for the time period 2009 to 2030, Pehnt et al. (2011) derive an energy saving potential of 183 TWh in the residential sector and 113 TWh in the commercial sector.

Breaking down this aggregate estimate shows the largest energy saving potential can be leveraged by better insulating the existing residential building stock, exchanging heating systems and requiring strict efficiency standards for new residential buildings, followed by the same areas of improvement in the commercial building stock (Martin Pehnt et al., 2011). Currently, 65% of all buildings' facades and 30% of all roofs are not insulated and another 20% of facades and 35% of roofs do not meet today's technical standards (Kohler, 2012).[40] Another area where significant electricity saving potentials could be exploited is the exchange of inefficient electric appliances such as refrigerators, washing machines or dryers in households, as well as cooling and freezing or office equipment in the commercial sector. A slightly smaller saving potential can be leveraged through intelligent lighting solutions, where the saving potential in the commercial is higher than in the residential sector (Martin Pehnt et al., 2011). The "landscape" of energy saving potentials in both sectors is illustrated in Figure 12.

[39] The German Energy Agency (Dena, 2012) estimates that the residential sector's final energy consumption could be reduced cost-effectively by 121 TWh by 2020 compared to 2008 (heating: 112 TWh, electricity: 9 TWh). This would equal a reduction of 17% compared to 2008 levels. The commercial sector shows a cost-effective saving potential of 67 TWh (heating: 52 TWh, electricity: 15 TWh), while industry accounts for a saving potential of 75 TWh (fuels: 48 TWh, electricity: 27 TWh). As there is no information available on how these potentials were calculated, they were not used for further analysis.

[40] "Not meeting today's technical standards" means that insulation thickness is below 9 cm for facades and below 13 cm for roofs (Kohler, 2012).

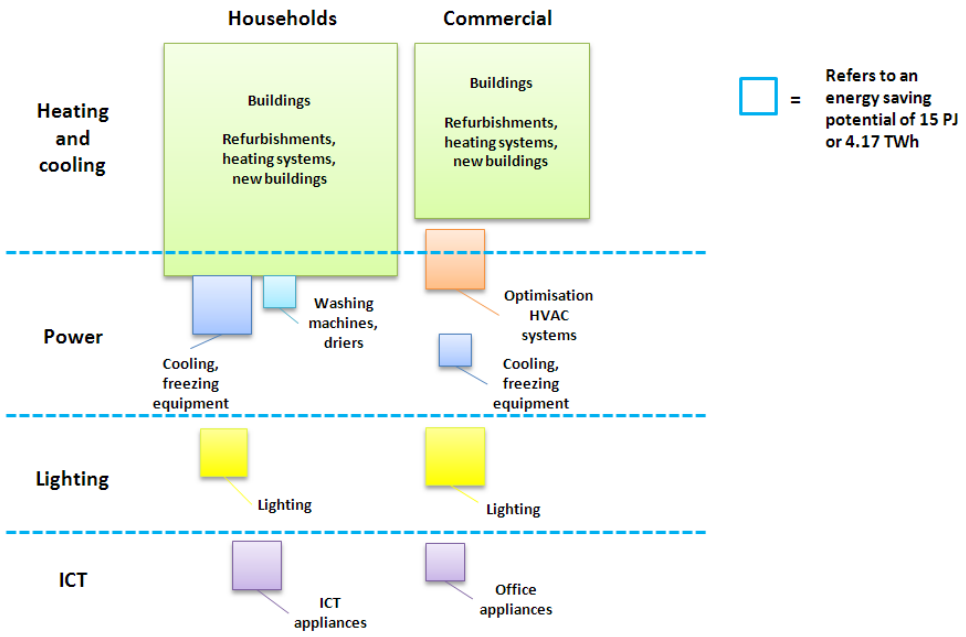

Figure 12 - Landscape of energy saving potential in the residential and commercial sector

Source: Own illustration adapted from Pehnt et al. (2011)

5.3.2 Identification of eligible measures for on-bill models

Based on the identified energy saving potentials in the residential and commercial sector, it was assessed if specific energy saving measures from these areas would be attractive under on-bill programmes. Existing publications were scrutinised for data on technology and installation costs and energy savings (Becker et al., 2014; BMVBS, 2012a, 2012b, 2013).[41] It should be noted that there are significant deviations regarding costs and savings in the available literature and that consulted energy efficiency experts raised concerns that the applied estimates for energy saving potentials might be too optimistic. The following economic assessment should therefore be treated with caution.

Only those measures were chosen for further analysis where annual energy cost savings exceeded annual payments. Annual payments were derived from three components. First, technology and installation costs were drawn from existing literature. A conservative approach was chosen by working with full costs instead of energy related incremental costs. This distinction is particularly relevant for insulating the building shell where full costs are often two to four times higher than energy related incremental costs (Becker et al., 2014; Weiß & Dunkelberg, 2010). For measures installed in residential buildings the costs resemble literature values for relatively large, modernised detached family houses.[42] Providing estimates for other types of buildings was out of scope for this thesis. Choosing this type of reference building can be justified as detached and semi-detached houses account for 83% of the residential

[41] For this review only those studies were chosen that provide specific data on costs and savings for the German context. Material costs, labour costs, business profit and professional fees differ significantly between countries (Boneta, 2013).

[42] The data was derived from two studies with slightly different reference buildings. The reference building in Becker et al. (2014, p. 126) has the following characteristics: Detached, modernised family house built 1958-1968, floor area 242m², Energy performance: roof: 0.25 W/m².K, walls, 0.34 W/m².K, windows 1.3 W/m².K, floor 0.52 W/m².K, heating system: low-temperature boiler from 1987-1994. The BMVBS (2012a) reference building's characteristics are: Detached family house, floor area 296 m², heating demand: 110 kWh/m²a, heating system: condensing gas or oil boiler which was installed before 1994. It was not assumed that replacing heating system will be accompanied by switching the energy carrier.

building stock (Bigalke et al., 2012). Furthermore, these two building types are particularly relevant for reducing the overall energy demand from the residential building stock, as the specific heating requirements per square metre of living space is higher than in multi-family buildings (Weiss et al., 2012). Due to a lack of data only one measure targeting the commercial sector was included in this economic assessment.

After identifying adequate data for technology and installation costs, programme costs amounting for 700€ per measure were added based on data provided by Green Deal providers, except for the refrigerator replacement where 180€ were assumed to be more suitable based on data from an existing mini-contracting model (A. Mucke, personal communication, July 16, 2014). While the 700€ estimate is significantly higher than reported data for most OBF programmes in the U.S. (H. Lachman personal communication, July 8, 2014), it is below typical costs of providing one Green Deal financing plan (Green Deal providers, personal communication, various occasions). Compared to data provided by Berlo et al. (2011) on costs faced by municipal utilities for designing an energy efficiency programme, administration, marketing, client consultation and programme evaluation, the estimate is located in the medium range. In a last step, financing costs were added, assuming that providers are able to pass on an interest rate of 3% to their customers. All costs were added up and spread over 85% of the measures' lifetime.[43]

Energy cost savings were calculated based on energy prices for households and commercial customers from 2012.[44] If future energy prices rise, annual savings will increase over time compared to the reference case where no efficiency measures would have been installed. If energy prices decrease, savings will be lower than illustrated. Measures were excluded where annual repayments exceeded 85% of estimated energy cost savings, as it was regarded as crucial to provide a 15% buffer to programme participants for two reasons. First, as already discussed, under on-bill programmes savings are not guaranteed and estimates provided by energy assessors might be inaccurate. Second, customers should see an immediate benefit in participating in the programme. This would not be given if payments would be allowed to account 100% of the savings. Third, due to rebound effects of different scales, many participants are likely to face higher energy bills than before the installation. This risk will be reduced by limiting annual repayments to 85% of annual energy cost savings.

It should be noted that no discount rate was applied for future energy savings, as no research has been carried out on consumer behaviour and their implicit discount rates under on-bill programmes. Assuming that on-bill financing would offer consumers a largely risk free energy efficiency service (due to long-term warranties for installed technologies and an attachment of the payment obligation to the meter) which comes at no up-front costs, applied discount rates should be relatively low. The following calculation has the simple purpose to illustrate which measures would be eligible for on-bill models under the assumed programme requirements. All measures which have been identified as eligible are presented in Table 5. The majority of assessed measures would not pay for themselves under the assumed conditions. These measures are efficient windows, roof isolation, solar-thermal systems, replacing old gas and oil boilers by pellet boilers and hydraulic balancing for existing boiler driven heating systems. Particularly, those measures which are on the border to being eligible for on-bill financing,

[43] Again, an exception was made for the refrigerator as it is the only portable measure. The low investment volume and relatively high savings allow for a shorter payment period of five years.

[44] Energy prices 2012 for households: electricity: 0,2873 €/kWh, gas: 0,0648 €/kWh, oil: 0,0896 €/kWh, pellets: 0,0550 €/kWh; Commercial sector: electricity 0,2414 €/kWh. Based on Becker et al. (2014, p. 133).

such as hydraulic balancing, might be attractive when bundled with highly cost-effective efficiency measures, provided that total payments do not exceed 85% of the savings.

*Table 5 - Non-exclusive list of eligible measures for on-bill financing based on *Becker et al. (2014), **BMVBS (2012a), ***(WSW, 2013)*

Measure	Electricity (kWh)	Gas (kWh)	Oil (kWh)	Full costs (€)	Payback (years)	Saving (€/a)	Payment (€/a)
Single-family home facade renovation BAT 0.12 W / (m² K)*	300	-	17400	21,400 - 24,900	25	1,645	1,334
Replacement night storage heaters by gas central heating*	15,800	-17,400	-	10,850	13	3,412	1,086
Replacing old gas standard boiler to condensing gas boiler**	-	11,941	-	5500	16	774	494
Replacing old oil standard boiler to condensing oil boiler**	-	-	9,460	8,800	16	848	701
Replacing old fridge by A+++ model***	682	-	-	450	5	196	138
Replacing lighting in commercial buildings**	3,500	-	-	3,000	13	845	282

The assessment of specific measures shows that on-bill financing is not a suitable instrument for deep refurbishments, but could be an attractive option for highly cost-effective measures, such as exchanging single-family houses' heating systems or replacing inefficient electronic devices. Compared to experiences reported from the How$mart programme it is remarkable that in Kansas the exchange of boilers usually requires an additional capital injection from the consumer, while insulations have been proven to be highly cost-effective. The data for the German context turns this observation on its head. It suggests that the full costs of a boiler exchange could be financed in an on-bill model, while most insulation measures cannot.

Overall, the economic assessment illustrates that a significant amount of measures could be eligible and that on-bill programmes could have an *impact* alongside the existing energy efficiency instruments. However, it should be emphasised again that the results of this assessment underlie a certain degree of uncertainty, as technology and installation costs as well as energy savings are not static, but highly context specific and the reliability of values from the existing literature has been questioned by interviewed experts.

5.3.3 Overcoming context specific barriers that reduce the impact of on-bill models

The following section will analyse context specific barriers that might reduce the impact of on-bill models in Germany. The barriers were mostly identified in semi-structured interviews with

experts from the German energy efficiency policy arena. To transfer existing experiences regarding potential solutions on how these barriers could (partly) be overcome, the identified issues were also discussed with on-bill experts from the U.S. and the UK.

5.3.3.1 Need for adequate metering and billing systems

In contrast to the UK and in Kansas, most German households and small businesses do not get a feedback on their actual electricity use through a monthly bill. Monthly payments for grid-bound energy carriers, such as electricity and gas, are usually based on an estimate of actual energy use. Residential customers start paying a billing amount, which reflects the average use for the corresponding household size. After a year the actual energy use is checked. The consumer either pays money to the utility if energy use was higher than estimated or the consumer gets money back if it was lower. Afterwards, monthly payments are adjusted to better reflect actual consumption levels. For on-bill programmes this billing system creates several challenges. First, most consumers are poorly educated about their actual energy use. Second, if monthly payments are not lowered by the estimated energy cost savings, consumers do not see an immediate benefit in participating in the programme. However, if monthly payments are reduced after the efficiency improvement has been implemented, but the estimate of energy cost savings proved to be wrong, consumers face the risk of paying back a significant amount of energy debt, which accumulated over the first year. For the same reason programme participants' electricity bills remain constant for the first year despite yielded savings under the existing mini-contracting programme for efficient fridges, operated by the local energy supplier Wuppertaler Stadtwerke (A. Mucke, personal communication, July 14, 2014). This risk related to accumulating energy debt could be reduced by using a certain safety margin, even though a timely feedback on actual consumption would be more desirable.

When the building is not connected to a grid-bound energy source the consumer does not receive any direct feedback on energy use for space heating and warm water. This is the case for one fourth of all German apartment's where heating systems are based on boilers connected to oil tanks (Diefenbach, Cischinsky, Rodenfels, & Clausnitzer, 2010). In similar cases in the U.S., the electricity supplier acted as the energy efficiency provider. A charge is attached to the electricity bill, even though savings accrued from a reduced use of locally stored propane or natural gas (H. Lachman, personal communication, July, 1, 2014).

Furthermore, in the German rental sector it is very common that heating expenses are included in the rent. Interviewed experts from the U.S. argued an OBF model could still work if the prerequisite is fulfilled that benefits and OBF charges are borne by the same person, here the tenant. The landlord could collect the surcharge from the tenant and pass it on to the heating supplier. The incentive for the landlord is to receive an improvement of the property without bearing any costs (H. Lachman & M. Volker, personal communication, various occasions). The situation gets more complex in multi-apartment buildings with no metering system is in place that allows measuring the tenant's actual energy use. In Germany, the landlord is obliged to provide for individual metering. However, there are some exceptions to this rule, for example, in old multi-apartment buildings where the installation of individual meters would not be cost-effective after ten years (§ 10 HeizkostenV, BGBl. I S. 3250). In this type of buildings there is often only one meter in place. The total buildings' energy use is then spread over the number of square meters and allocated to the apartments. As improvements are shared by all residents of the building the energy cost savings could also be distributed by square meters. If energy efficiency improvements are only carried out in a certain share of apartments, the rent of the beneficiaries would need to be adjusted.

Aligning incentives by introducing a fixed price for energy in the rent and locating all benefits on the landlord's side, as it has been observed in Kansas (Burr, 2013), would be illegal in

Germany. Landlords are required to pass on energy savings to their tenants, as heating expenses in the rent need to reflect tenants' actual consumption (HeizkostenV, BGB).[45]

Overall, the challenges seem to be solvable. However, an individual and timely metering of consumers' actual energy use would improve the situation significantly. The EED encourages the introduction of "individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use" for all relevant energy carriers (Art 9. Directive 2012/27/EU, OJ L 315/1).[46] However, the EED also contains a clause which states that new meters only need to be introduced if their installation is technically possible and cost-effective. The German Federal Ministry for Economic Affairs (BMWi) has commissioned a cost-benefit analysis of the roll-out of smart meters and metering systems. The results suggest that a roll-out of smart metering systems[47] for energy consumers with an annual electricity consumption above 6,000 kWh and a roll-out of smart meters for smaller consumers is cost-effective from a micro and macro-economic perspective. The roll-out of smart meters for gas was not recommended, as the installation was found to be too costly (Ernst & Young, 2013). However, the study did not account for the potential benefits related to new services, such as OBF, that could be facilitated by a roll-out of smart meters.

5.3.3.2 Need for capacity-building along the supply chain

According to the developer of PAYS® a good contractor network is one of the crucial factors for making OBF programmes work (H. Lachman, personal communication, August 4, 2014). Several interviewed energy efficiency experts from the German energy efficiency arena were sceptical that current educational programmes and accreditation systems are adequate to ensure a high quality of energy assessors and installers. It was also questioned if energy suppliers are well prepared to act as an energy efficiency service provider and run on-bill programmes. This problem cannot be solved by an intelligent policy design for on-bill financing alone, but needs to be embedded in a larger initiative for an improved capacity-building along the whole energy efficiency supply chain. Based on the lessons learned from the UK, an elaborate accreditation system for on-bill finance providers can be expected to come at significant costs. If instead energy suppliers act as financiers and cooperate with energy efficiency service providers in a contracting network, economies of scale could be realised and parts of the quality assurance can be expected to be exercised by the supplier that aims to establish a long-term relationship with its customers and business partners.

5.3.3.3 Need to persuade relevant stakeholders

The German energy system is currently undergoing a radical transition that naturally creates winners and losers. Many large electricity and gas supplier struggle to make profit under current market conditions. Therefore, suppliers are looking for new business models. In a recent survey, 54% of responding energy suppliers reported that extending customer services is part of their business strategy (Pressetext, 2014). This could be a facilitating factor for OBF

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[45] If landlords modernise their rental property, they are allowed to increase the annual rent (exclusive of heating) by 11% of the modernisation's costs. Only incremental costs over maintenance work can be allocated to the tenant (§ 559, BGB). Under current market conditions the 11% modernisation allocation is often insufficient to recover the costs of an energy efficient retrofit (Henger & Voigtländer, 2011). From the tenant's perspective the rent increase due to the modernisation allocation might be (partly) offset by energy cost savings, which are reflected in the total rent (inclusive of heating).

[46] By 2020, 80% of all consumers in the EU should be provided with smart metering systems for electricity. No schedules are provided for the roll-out of metering systems for other energy carriers (Art 9. Directive 2012/27/EU, OJ L 315/1).

[47] The EED defines smart or intelligent metering systems as "an electronic system that can measure energy consumption, […], and can transmit and receive data using a form of electronic communication" (Art 9. Directive 2012/27/EU, OJ L 315/1). In contrast, smart meters are not connected to a communication network (Ernst & Young, 2013).

programmes. However, under these conditions of high uncertainty, it will be crucial to carefully consider all actors' interests. An in-depth stakeholder analysis was out of this scope for this thesis, but several insights have been gained in expert interviews (see Figure 13).

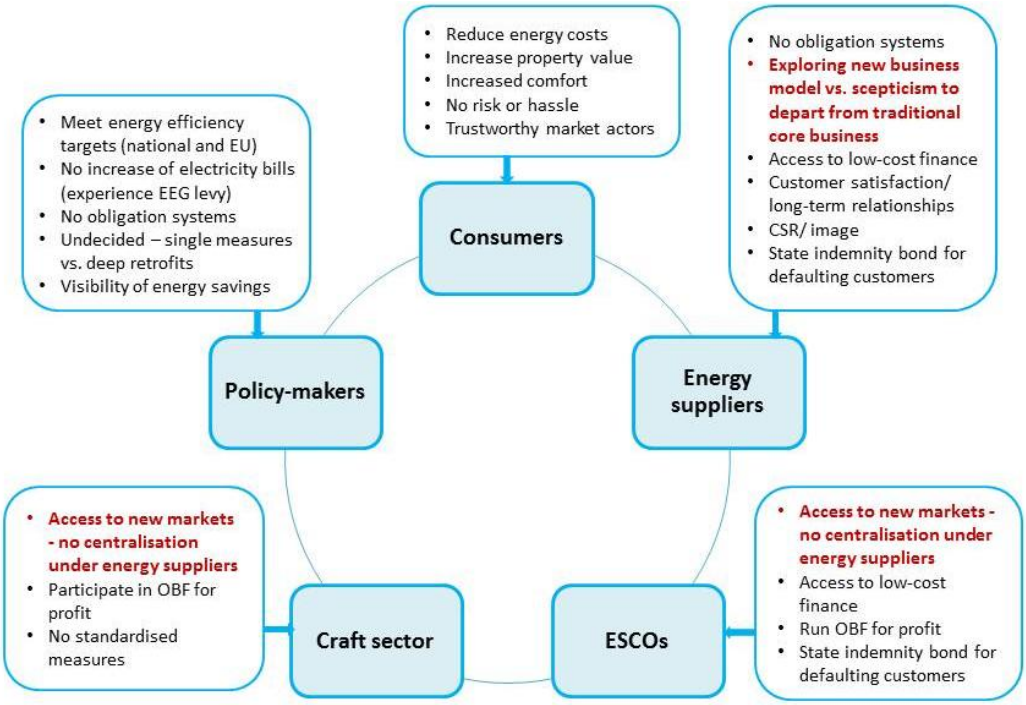

Figure 13 - Stakeholders' interests with regards to on-bill financing

Source: Own illustration based on expert interviews on various occasions

As highlighted in red colour, conflicts can be expected when deciding who is going to be allowed to act as an on-bill finance provider. Policy-makers face a trade-off between keeping the design simple from a customer's perspective by placing the energy supplier at the heart of the scheme (How$mart®) or opening it up to a wide array of market actors, accompanied by potentially costly accreditation processes and a higher degree of complexity (Green Deal).

5.3.3.4 Need to account for differing legal traditions

A legal assessment with regards to OBF in the German context was also out of scope of this thesis. It is therefore unclear if the legal practice in the U.S. and the UK, such as tying the payment obligation to the building's meter, is transferrable to the German context. R. Loch from the Consumer Association North Rine-Westfalia (personal communication, June 13, 2014) raised concerns that German consumers might be unwilling to experiment with a new financing mechanism attached to the building's meter, as consumers tend to have a rather conservative relationship to their property (which is well reflected in the German term "Eigenheim"). This potential cultural barrier might be even higher if utilities insist on filing a lien to the property when providing finance for energy efficiency improvements. This is common practice under the How$mart® programme, but is not recommended by the PAYS® system. In Germany, an entry in the land registry (Grundbuch) is already applied for leasing photovoltaic systems or energy supply contracting models for efficient heating systems. If these models prevail, it can be assumed that liens might be more accepted in the future.

Another legal challenge will be to find the right balance between allowing suppliers to use on-bill programmes for increasing customer loyalty and prevailing consumers' freedom to switch suppliers. This could possibly be circumvented by limiting the customer retention to a certain time period, e.g. 3-5 years, and by legally obliging all utilities to continue the collection of

payments and forwarding them to the utility where the initial contract was arranged. As in the UK, the new energy supplier that does not benefit from the initial energy efficiency service contract could receive a small fee as a reimbursement for the administrative effort.

5.4 Evaluating the predictability of on-bill policy instruments

Based on the lessons learned from the analysis of the PAYS® intervention theory and the design and performance of the How$mart® programme and Green Deal (see chapter 3), it is recommended to encourage on-bill programmes that implement the service-based OBF model, with a strong role of the utility as the energy efficiency service and finance provider, as well as high levels of consumer protection. Furthermore, it will be crucial to provide utilities who engage with OBF programmes with access to low cost finance, as the level of interest is a crucial factor for the eligibility of energy efficiency measures. Four design options have been developed that vary in their degree of coerciveness for encouraging the introduction of OBF models by utilities operating in the German electricity and gas market:

Voluntary

(1) The policy intervention is limited to creating the required legal conditions (particularly for attaching the payment obligation to the meter). It might be complemented by public campaigning. In this case it is up to the market to decide if OBF programmes are an attractive solution for tapping unexploited energy saving potentials. Utilities and where appropriate independent ESCOs cooperating with utilities, can choose to offer households and businesses OBF programmes for efficiency improvements.

(2) Again the required legal conditions are provided by a policy intervention and the up-take of OBF models is left to the market. However, financial incentives are provided to utilities to encourage the introduction of OBF programmes. This could be organised through a "Funding Directive" (Förderrichtlinie) which lays down the requirements to apply for grants from the Energy Efficiency Fund.

(3) The legislator requires energy utilities to offer the installation and financing of efficiency measures based on the OBF model to their customers. However, no targets regarding saved energy, sold products or reached customers are mandated by the policy intervention. Utilities only need to prove that they have an OBF programme in place. They can decide to outsource the implementation of the OBF programme to a third party, for example an ESCO.

(4) The legislator requires utilities to offer OBF by linking it to an energy company obligation system. Here, the government or another public authority establishes energy savings targets for certain time intervals. These targets have to be met by all gas and electricity suppliers above a certain size through the implementation of energy efficiency measures with final energy users. By linking the obligation system to OBF the costs for delivering the defined amount of energy savings are not spread over the energy prices of all end users. Instead, the household or business that benefits from an efficiency measure pays back the investment costs and a margin for the utility on the energy bill. Similar to the UK ECO, the legislator could require that a certain proportion of the savings must be delivered in specific customer segments, for example with the aim of supporting low-income households. To encourage deeper renovations the legislator could demand that a further portion of required energy savings must be achieved through specific measures. If in these cases costs exceed the energy cost savings, the legislator could allow to pass on the incremental costs through the energy price to all end users. Again, a negative distributional effect on end users who do not benefit from efficiency improvements would be smaller than in the conventional utility obligation model.

Mandatory

To ensure compliance with all policy options a federal oversight body needs to be installed. Furthermore, the introduction of sanctions ranging from financial penalties to a loss of operating licenses in case of severe infringements should be considered.

The *predictability* of outputs, in terms on-bill programmes on the market, and outcomes, the energy efficiency measures installed and financed under these programmes, increases with the level of coerciveness. Predicting outputs and outcomes for policy option 1 and 2 was not feasible as data was missing with regards to crucial assumptions, e.g. the willingness of energy suppliers to introduce on-bill programmes, consumers' up-take and the amount and type of energy efficiency measures installed. For policy option 3, the number of introduced on-bill programmes is given, as it is mandated by policy-makers. A quantitative analysis of the amount and type of energy efficiency measures provided and energy savings yielded is presented in section 5.4.1. Policy option 4 offers an even higher degree of predictability. As the amount of energy savings is mandated by policy-makers a bottom-up analysis of energy savings would not add value to evaluate the instrument's effectiveness. Administrative costs are difficult to predict under all designs and are excluded from the following assessment.

5.5 Evaluating a specific policy instrument's effectiveness in terms of energy savings and their persistence

Out of these four options, option 3 has been chosen for an analysis of its *effectiveness* in terms of induced energy savings. As the legislator obliges energy suppliers to offer an OBF model for energy efficiency improvements, all energy consumers would have access to on-bill financing. The assumed programme design resembles the How$mart® programme, an OBF model run by utilities with access to low cost finance. Therefore, it was assumed that similar participation rates would be achieved, even though there is a significant degree of uncertainty if the experiences made in the U.S. can be transferred to the German context. To account for this uncertainty, instead of an observed participation rate in Kansas of 0.43% of all customers per year, it was anticipated that 0.4% of all households and business from the commercial sector would be reached. In absolute numbers this would mean that every year 191,290 households and 63,763 businesses from the commercial sector agree to on-bill financing.

Based on the economic assessment of specific energy efficiency measures (see Table 5), it is assumed that 50% of participating households use OBF for replacing their old gas or oil standard boiler with a more efficient gas or oil boiler. Another 20% finance the efficient renovation of a single-family house facade, 10% replace their night storage heater and 20% exchange their old fridge. Furthermore, it was assumed that all participating businesses use OBF for switching to efficient LED lighting systems. Under these circumstances, final energy savings would amount to 1.37 PJ electricity and 4.15 PJ fuels (gas and oil) in the first year. If on-bill programmes would be introduced in 2015 and run over the next five years yearly cumulated final energy savings would amount to 8.23 PJ electricity and to 24.9 PJ fuels in 2020. The results in terms of final and primary energy savings[48] are illustrated in Table 6.

Cumulated final energy savings from 2015 to 2020, account for 115.9 PJ. With regards to the EED "implementation gap" of 502 PJ, the policy design option 3 could therefore potentially deliver 23% of the required energy savings. Regarding the instrument's *effectiveness*, this exemplary calculation suggests that offering OBF for the residential and commercial sector

[48] For calculating primary energy savings the conversion factors of the "Climate Protection Scenario 2050" was applied . For the year 2014 and 2020 the same conversion factors were applied, even though it can be assumed that the factor will need to be adapted to due an increasing share of renewable energies.

will on its own not close the gap between current levels of efficiency improvements and politically defined targets. However, it could deliver a significant contribution, even without politically mandated energy savings targets for energy suppliers or further economic incentives, e.g. in form of grants for energy consumers.

Table 6 - Induced energy savings of on-bill financing under the policy design option 3

	Yearly cumulated energy savings in 2015	Yearly cumulated energy savings in 2020
Final energy	[PJ]	[PJ]
Electricity	1,37	9,60
Fuels (oil and gas)	4,15	29,05
Primary energy	[PJ]	[PJ]
Electricity (Factor 2,34)	3,21	22,46
Fuels (Factor 1,1)	4,56	31,95

It should be noted that this calculation certainly overestimates actual energy savings as it does not account for free rider effects (assuming that some consumers would have installed the measure anyway) and reduced energy savings due to low quality installations or technologies. Regarding the *persistence* of energy savings it is assumed that a certain share of energy savings induced by energy efficiency improvements under OBF will be offset due to increased thermal comfort or convenience. Greening et al. (2000) reviewed 75 studies and indicated that estimates for "rebound effects" for space heating range between 10% and 30%. Studies on "rebound effects" in the German context identified similar to slightly higher effects (Erhon, 2007; Kaßner, Wilkens, Wenzel, & Ortjohan, 2010; Rosenow & Galvin, 2013).

5.6 Evaluating the flexibility regarding future policies

It is hard to predict which instruments might be introduced in the near- to medium-term future. While the discussion on the design of a potential energy company obligation is still on-going (see: Becker et al., 2014; Bürger, Rohde, Eichhammer, & Schlomann, 2012; Schlomann et al., 2012), interviewed experts from the policy arena are sceptical that an introduction is politically feasible under current conditions. OBF can be encouraged on a voluntary basis, but later linked to an obligation system that mandates energy savings targets for electricity and gas suppliers. As the introduction of a new levy can be regarded as very unpopular in light of the rising electricity prices and a lot of bad press for the renewable energy levy (EEG Umlage), OBF might be an interesting option to mitigate the distributional effects of an energy company obligation. Here, costs are largely borne by beneficiaries of efficiency improvements and not by all customers in form of higher energy prices (see design option 4).

Another model to leverage funding for energy efficiency improvements is a tendering model (see: Dinges et al., 2014; M. Pehnt & Brischke, 2013). Both studies suggest that market actors can access funding for energy efficiency programmes that implement standardised measures, e.g. the exchange of heating systems or a switch to efficient lighting systems. Available funding could be used to deliver seed capital to energy suppliers that are interested in setting up on-bill financing programmes. Furthermore, it could be assessed if these suppliers that voluntarily adopt OBF, might receive attractive credit lines with the KfW to provide particularly smaller suppliers with access to low-cost capital that they can pass on to their customers.

Overall, encouraging the introduction of on-bill programmes can be pursued via different policy instruments ranging from economic instruments (carrots) to regulatory instruments (sticks). A necessary degree of *flexibility* can therefore be regarded as given.

6. Discussion

This chapter discusses the research's methodological choices as well the key insights gained on on-bill programmes and the context-specific insights of the cases under analysis. Furthermore, the findings will be compared to the existing literature on on-bill programmes.

6.1 Methodological considerations

With due limitations, the methods for data analysis for the ex-post as well as for the ex-ante evaluation have been suitable to systematically assess the two research questions that built the foundation for this thesis. Methods for data collection, particularly the survey targeted at Green Deal providers, would have been revised, if the amount of information gathered by the end of the thesis period had been available at the early stages. Carrying out a trial survey would have been helpful. The gathered data would allow for a more thorough interpretation if survey participants would have been provided with the specific components of capital costs from the beginning and if accreditation costs would have been assessed separately from operational costs. Given the current state of knowledge, the survey should have also accounted explicitly for providers' activities in the ECO market. Now, it was often unclear whether the point of time when the accreditation process was completed was the same as when the provider started to sell Green Deal plans. This caused uncertainties when determining the period of time where TCs, ACs and marketing costs were accounted for in relation to total capital costs.

As probably any other research project, this thesis was constrained by data limitations. The principle of triangulation could not be fulfilled in all cases. Semi-structured interviews were a major source of empirical data and it was not feasible to back up all quoted statements with a second source from literature. Furthermore, the survey did not deliver the desired kind and statistical amount of quantitative data. For example, it would have been interesting to derive estimates of the scale of ACs, TCs and marketing costs per saved kWh or in relation to the capital costs of specific technologies. These results could have provided interesting insights in a comparison with the findings from Mundaca (2007) for energy savings delivered under the EEC a predecessor of the ECO. The gathered data from the research at hand did not allow for such an analysis. Only three Green Deal providers gave an estimate of energy savings yielded by the measures installed under their Green Deal plans, ranging from "up to 150,000" kWh to "up to 300,000 kWh". Two respondents evaluated TCs with regard to specific technologies, which were assessed as particularly high for biomass boilers, easy-to-treat cavity wall insulations and loft insulations (see illustration in Annex III).

Taking into account these methodological challenges, it would be interesting to carry out a second survey in half a year to observe potential learning effects regarding levels of TCs, ACs and marketing costs. Other areas for future research are highlighted in the following sections.

6.2 Key observations from the ex-post evaluation

The ex-post evaluation showed that carefully designed on-bill programmes can be a suitable instrument to overcome certain barriers to energy efficiency investments. In the terms of Pawson and Tilley's (1997) *Realistic Evaluation*, on-bill programmes are able to trigger "mechanisms for change" that counteract old, inhibiting mechanisms.

The major prerequisite for unsubsidised on-bill programme to work is that significant cost-effective saving potentials can be leveraged. If there is no need for the consumer to invest from her own pocket, one can argue that the barrier high-up front costs paired with lack of available capital can be fully overcome. Providing finance in form of an energy efficiency service, as suggested by PAYS® and implemented by How$mart, can be regarded as highly

attractive for those energy consumers who are traditionally unwilling or unable to finance energy efficiency measures from their own pocket or by taking out a loan. Furthermore, by strictly tying the repayments to the beneficiary of energy savings, incentives can be aligned in a manner that solves the split incentives dilemma between landlords and tenants. Having the up-front costs covered by a third-party and attaching the payment obligation to the property can be identified as the two essential facilitating factors for encouraging the up-take of efficiency improvements. Furthermore, on-bill programmes are able to shift a certain share of future energy cost savings to the present by requiring repayments not to exceed a certain share of energy savings. This reduces disincentives with regards to long pay-back periods. Even though not all consumers react to economic incentives (CCC, 2009), aligning the timing of cost and benefits should be a facilitating factor for reducing high levels of inertia related to consumers' implicit discount rates for future savings (Hausman, 1979; Howarth & Sanstad, 1995). Whether programmes are able to overcome consumers' risk aversion is highly dependent on the design in terms of required warranties and other mechanisms for consumer protection. Neither the How$mart® programme, nor the Green Deal delivers the levels of consumer protection, e.g. product warranties, as it is envisaged by the PAYS® system.

From a provider's perspective investments made under on-bill programmes can be regarded as relatively secure. The rate of non-payment is usually below 1% as programme participants risk to be disconnected from utility services (Hayes et al., 2011). Even though on-bill programmes' might not be able to deliver a significant rate of return on investments made, they can be a suitable instrument for yielding indirect benefits, such as gaining competitive advantage by increasing customer loyalty, image campaigning and experimenting with new business areas.

These general cautiously positive observations are supported by an emerging body of (mostly grey) literature (ACEEE, 2012; Bell & Nadel, 2012; Burr, 2013; Zhang, 2013). However, the barrier analysis structured by the PAYS® intervention theory should not be understood as an exclusive list of barriers to the take-up of energy efficiency measures. Other hindering factors, such as the hassle related to construction work, are not overcome by on-bill programmes.

The findings from the comparative analysis showed that the design of How$mart® is more effective in overcoming the analysed barriers than the Green Deal. Based on empirical findings as well as theoretical considerations, it can be argued that in general OBF models are more effective in overcoming market barriers to energy efficiency than OBR models. Firstly, consumer research has shown that consumers are highly reluctant to take on debt. Secondly, paying for an energy efficiency service and not for a loan should reduce the hassle related to contractual sequences customers have to go through. It is relatively straightforward to argue that reducing complexity, e.g. by waiving a check of creditworthiness, can be assumed to translate into lower administrative and transaction costs. However, it would be interesting to quantify these costs not only on the provider's, but also on the consumer's side to back up this finding with stronger empirical evidence. Thirdly, becoming a lending institution is relatively far from utilities conventional business model. Utilities often lack the know-how on consumer lending laws and capacity building to navigate this new business area is often very costly. Introducing a tariff under an OBF programme is not as far from the traditional business model. A drawback is that in the U.S. utilities have to undergo a regulatory approval for introducing a tariff (ACEEE, 2012). It was not assessed how difficult it is for utilities to pursue such an approval. Furthermore, no clear answer was found, whether OBR programmes are able to deliver higher levels of security for finance providers than less formalised OBF programmes. Both questions could be the subject of future research projects.

Another key observation is that it is advantageous to place one strong actor, usually a utility, at the centre of on-bill programmes, independent from the OBF and OBR categorisation. In

contrast to ESCOs, utilities can build on existing relationships with their customers, which is particularly relevant for local cooperatives. Using customer data and existing payment streams, in form of the energy bill, reduces the complexity of the programme design (ACEEE, 2012; Bell et al., 2011). Commissioning an ESCO or another third actor to operate the programme for the utility should be examined carefully, as sensitive data is at stake. Overall, there is a trade-off between keeping on-bill programmes open for high a number of actors, as under the Green Deal, and providing a simple and streamlined scheme with high levels of consumer protection at reasonable costs. The experience in the UK shows that opening a programme to all kind of actors (ranging from small start-ups to experienced energy efficiency providers) while still aiming for a high level of consumer protection requires a robust accreditation scheme. On the one side, putting a "government stamp" on such an accreditation scheme should increase consumer confidence; on the other side, it comes at considerable costs for the state, market actors and in the end for consumers. As it was illustrated in section 4.3.7.1., accreditation costs were the most significant source of TCs for Green Deal providers. For the two providers where data allowed for a direct comparison, accreditation costs even outweighed the total investments in energy efficiency and renewable energy technologies.

In contrast, according to H. Lachman (personal communication, August 4, 2014) a high level of quality assurance at little incremental cost is achieved under the PAYS® system by allowing utilities to pick the best contractors without a highly formalised accreditation system. As more than 50% of approached customers under programmes based on PAYS® tend to say *yes* to an efficiency improvement, it can be regarded as a vibrant market place from a contractor's perspective. This should create an incentive for contractors to provide high quality products and services at relatively low costs to qualify as a business partner for the programme operator. Through establishing a bidding system the programme operator is able to choose the best offers at the lowest cost. It would be highly interesting to compare the costs of such a system to the Green Deal. Unfortunately, no detailed data could be gathered for the How$mart® programme, which follows the PAYS® system in this aspect. Future research could assess the five trademarked PAYS® programmes with regards to quality assurance as well as administrative and transaction costs faced by the provider, contractors and consumers.

6.3 Context specific observations

The How$mart® programme and the Green Deal were chosen to provide the first in-depth comparative analysis between an OBF and an OBR programme, which was so far missing in the literature on on-bill programmes. Furthermore, the available literature was either focussing on on-programmes in the U.S. or the Green Deal as the first on-bill initiative in Europe (ACEEE, 2012; Bell et al., 2011; Bell & Nadel, 2012; Hayes et al., 2011; Johnson et al., 2012; Lachman, 2013; Rosenow et al., 2013; Zhang, 2013). By carrying out a transregional analysis, this gap was aimed to be closed. A drawback of choosing two programmes for a comparative analysis that vary in many crucial aspects, is a reduced external validity of the case studies' findings (Yin, 2014). As presented earlier the How$mart® programme is a voluntary initiative from a relatively small utility. The Green Deal was a policy framework that aimed to engage as many market actors as possible. The design of the Green Deal differed in many crucial aspects. Therefore, it is hard to say to which extent the Green Deal's low effectiveness in overcoming the eight barriers (see section 4.5) can be attributed to its design as an OBR programme. For increasing the validity of the presented key observations on the OBF and OBR programme design it would be useful to analyse another OBR programme that is run by a utility in the U.S. This would hold more variables constant and allow clearer statements on the effect of designing the repayments as a tariffed utility service (OBF) or a loan (OBR).

In the following paragraphs it will be discussed how context specific mechanisms might have biased the How$mart® and Green Deal's performance to the better or the worse.

6.3.1 Green Deal

To understand why the Green Deal fell short of expectations the following context specific hindering factors need to be taken into account. First, the relatively high interest rate of 6.95% can be regarded as a major barrier, as it strictly limits the eligibility of energy efficiency measures that can be financed under the Green Deal alone (Holmes, 2011; Rosenow & Eyre, 2013; UK-GBC, 2014).

Second, linking the Green Deal to the ECO and the governmental subsidy scheme Cashback and HIF, has created a highly complex system with partly conflicting goals. While the ECO should have supported the provision of Green Deals, in practice it prevented many Green Deal providers from selling Green Deal plans, as solely engaging in the ECO market was regarded as more attractive (Green Deal provider, personal communication, June 18, 2014). Another Green Deal provider (personal communication, June 17, 2014) argued that providing subsidies in form of ECO funding and government grants sends the signal to consumers that the Green Deal is actually not such a good deal. These subsidies would therefore defeat their own purpose, which is triggering demand for the Green Deal. Other providers regarded the subsidy programmes as a facilitating factor for consumer up-take (Green Deal providers, personal communication, various occasions).

Third, the young history of the Green Deal has been characterised by unclear policy signals, which created numerous uncertainties. This problem might be even exacerbated in the near future. As the Green Deal has not delivered the envisaged amount of low-cost measures, DECC proposed to extend the list of eligible measures under the CERO, the first pillar of ECO (Stanger, 2013). This pillar was originally designed to provide funding for measures that are currently not meeting the Golden Rule, such as solid wall insulation. If the new proposal will be implemented, energy companies could deliver highly cost-effective measures, such as easy-to-treat cavity wall insulations under the first pillar of ECO. In this case, the Green Deal and ECO would become directly competing sources of finance for the same type of energy efficiency measures. A Green Deal provider argued that this approach would further "devalue" the Green Deal from a customer's perspective (personal communication, June 17, 2014). It would also undermine one the major underlying ideas of the Green Deal, to leverage highly cost-effective energy saving potentials through a market-based instrument, without providing additional subsidies. While the Green Deal was designed to deliver finance for cost-effective measures, the major component of ECO, should deliver funding for solid wall insulations. Steven Heath (personal communication, March 7, 2014) reported that Knauf Insulation had heavily invested in solid wall solutions and capacity building based on the policy framework developed between 2010 and 2012. These efforts might now be in vain. The "stop-and-go" of handing out grants under the Cashback scheme and the HIF is another example of the lack of long-term certainty for consumers and market actors.

The fourth inhibiting factor might be consumers' attitude towards energy efficiency improvements which is likely to work against the market-based logic of the Green Deal. Under previous energy company obligations, such as the EEC and CERT, many households received energy efficiency measures at artificially low costs or even for free (Mundaca, 2007; Rosenow, 2012). As Zoe Leader from the WWF-UK (personal communication, March 6, 2014) pointed out, consumers can be expected to show little appetite to fully pay for the costs of energy efficiency improvements and particularly for deeper retrofits of their homes. This finding is supported by consumer research carried out by the UK Committee for Climate Change (CCC, 2009). While more than half of property owners would be willing to invest in energy efficiency measures with a payback period for up to three years, this share drops rapidly for measures which require a payback period for four years and more. Interestingly, one third of all households seems to be unwilling to install an energy efficiency measure even

if it was provided for free (CCC, 2009). This raises the question if there is a general disinterest in energy efficiency improvements. Primary and secondary research provided different answers. While the representative from DECC (personal communication, March 6, 2014) evaluates the general interest in the reduction of energy costs as very high, Zoe Leader from the WWF-UK (personal communication, March 6, 2014) as well as the UK Green Building Council (2014) observe a considerable lack of awareness among consumers. An interesting interim position was taken by Steven Heath from Knauf Insulation (personal communication, March 7, 2014) who stated that there is a surprising disconnect between the extensive media coverage on to the poverty debate and an interest in energy efficiency. Commonly named reasons for rising fuel costs would be that energy companies are making too much profit and high green taxes. Interviewees from civil society and industry (Z. Leader & S. Heath, personal communication, March 6&7, 2014) concluded that it is of crucial importance to improve the government's communication strategy and establish a link between energy security, lower energy bills, and energy efficiency improvements in the existing building stock.

6.3.2 How$mart®

Unfortunately, there is much less data available to put the findings on the How$mart® programme into context. No secondary data could be accessed on consumers' willingness to invest in energy efficiency improvements or the state of the building stock in Midwest Energy's service area. It is therefore unclear, if the better performance compared to the Green Deal can be partly attributed to untapped highly cost-effective energy saving potentials.

One interesting observation which deserves discussion is that Midwest Energy evaluated the fact that How$mart® was introduced as a voluntary initiative as a crucial enabling factor for the good performance of the programme. It is was argued that being independent from any type of government intervention gave the utility more freedom in designing the programme and would have reduced overall programme costs, for example compared to the solar water heaters programme introduced by the Hawaiian Electric Company (HECO), which was politically mandated (Johnson et al., 2012). It can be debated if all kind of policy interventions necessarily increase programme costs and decrease the utility's ability to adapt the programme design to meet local circumstances. As suggested under section 5.4 policy-makers could only require utilities to have on-bill programmes in place and potentially mandate a certain amount of energy savings to be achieved in a given period of time. In this case, policy-makers do not need to get involved in design questions and leave them to the market.

6.4 Limitations of on-bill programmes

6.4.1 On-bill programmes as a purely market driven instrument?

As presented in the ex-post evaluation of How$mart® and the Green Deal, as well as in the ex-ante evaluation for the German context, on-bill programmes that require energy cost savings to be equal or to exceed repayments, cannot be regarded as a suitable instrument for encouraging costly deep retrofits of existing buildings. In the economic assessment for the German context (see section 5.3.2) only highly cost-effective measures revealed to be eligible for on-bill programmes, assuming programme costs of €700 per package and a moderate interest rate of 3%. This observation is supported by existing literature (Bell & Nadel, 2012; Burr, 2013; Fuller, 2008). Without further political support, the impact of on-bill programmes can be expected to be low once highly cost-effective savings potentials have been leveraged.

This key observation raises more questions about the economics and underlying motivations of on-bill programme operators. While How$mart® was designed to introduce efficiency improvements that are clearly in the customer's interest, the Green Deal and ECO also

promote efficiency improvements that are optimal from a societal perspective, but not highly attractive from a private perspective. This shifts the focus from privately cost-effective energy efficiency measures to leveraging socially cost-effective energy efficiency measures. Even though it is a reasonable goal to address socially cost-effective saving potentials from a policy perspective, it is crucial to keep in mind that all market participants need to see a benefit in participating in the programme. While under How$mart® the customer should enjoy lower energy bills (unless there is a significant rebound effect), it is the utility that only sees indirect benefits through increased customer satisfaction. Furthermore, seed capital was accessed through a governmental loan programme at subsidised interest rates, which means there is no lender is involved that seeks a significant rate of return on energy efficiency investments. Under the Green Deal, financing costs have not been lowered significantly through a government intervention. However, at an interest rate of 6.95% paired with high programme costs, Green Deal providers struggle to sell Green Deal financing plans and for most consumers benefits are not convincing enough to participate in the programme.

The question arises whether energy savings are generally insufficient to provide all actors, the customer, the provider, contractor and the lender, with significant financial benefits. Can OBF and OBR programmes work in a purely market driven framework, particularly where financing costs reflect the perceived risks that conventional banks attach to the programmes? Difficulties in covering the programme costs have been already observed in Merrian (2008) and Bell et al. (2011). Furthermore, in existing literature no on-bill programme could be identified where financing is fully delivered by the private capital market (Bell et al., 2011; Bell & Nadel, 2012). All OBR and OBF programmes in the U.S. where data on the sources of finance was available had access to some source of low-cost finance, which allowed them to pass on relatively low interest rates to the customer. The financing costs embedded in How$mart® are in the medium range compared to other OBR and OBF programmes in the U.S. with interest rates between 0% and 6%. Table 7 gives an overview over financing terms in other on-bill programmes in the U.S.

Table 7 - Financing costs of OBR and OBF programmes in the United States based on Bell et al. (2011); Bell et al. (2012); Cillo & Lachman (2013)

Programme name	Type	Capital source	Target sector	Loan size	Interest rate	Max. payback
Electric Cooperatives South Carolina: Rural Energy Savings	OBR	USDA's Rural Economic Loans and Grants Program (REDLG)	Residential Commercial	< $740,000	2.5%	10 years
Clean Energy Works Oregon	OBR	Seed capital ARRA funds, CDFI loan fund	Residential	$12,633 (median)	5.99%	20 years
Connectitute: United Illuminating	OBR	Seed capital ARRA funds, Revolving loan fund	Commercial	$8,000 - $12,000 (avg.)	0%	24-36 months
California Investor-Owned Utilities: SoCal Edison OBF	OBR	Ratepayer Funds, Revolving loan fund	Commercial	< $ 1,000,000	0%	
Massachusetts, New Hampshire, Rhode Island: National Grid	OBR	Seed capital from ratepayer and shareholder funds, Revolving loan fund	Residential Commercial Industrial		0%	

New Hampshire Electric Co-op: NHEC SmartSTART	OBF	Ratepayer funds, Revolving loan fund	Commercial Industrial	$10,000 (avg.)	5.41%	5 years
Midwest Energy: Kansas How$mart®	OBF	Kansas Housing Resources Corporation, Efficiency Kansas program, Rural Economic Development Loan	Residential Commercial Industrial	$ 7,489 (avg.)	0-8%	15 years
Electric Cities of Georgia: OBF	OBF	Federal funding source, Revolving Loan fund	Residential	> $5,000	0%	5 years

For on-bill programmes having a significant impact, one of the major challenges will be scale-up new and existing programmes by drawing more private capital into the programmes at acceptable financing costs (Bell et al., 2011). As long as private lenders attach high risk premiums to capital for on-bill programmes, these are unlikely to be purely market driven in the near future. Rising energy prices and lower costs for energy efficiency technologies might improve the economics of on-bill programmes. From a policy-perspective, working on the internalisation of external costs of the current energy system should be a key strategy to close this gap between private and social optimums of investments in energy efficiency. Furthermore, policy-makers could provide lenders with deficiency guarantees to reduce perceived risk until this innovative financing model is more established.

6.4.2 Low participation rates

Even though the analysis showed that on-bill programme can overcome certain barriers, both programmes, How$mart® and the Green Deal, are not able to show participation rates and the type of energy efficiency measures that would be needed for meeting the EU's, UK's or Germany's efficiency and climate targets. Policy-makers should not assume that introducing a policy framework for on-bill models will trigger refurbishments of large parts of the building stock (as initially expected in the UK), but as one instrument that contributes to tapping unexploited energy saving potentials. Furthermore, it needs to be acknowledged that consumers are largely passive and many consumers will not respond to pure economic incentives (CCC, 2009). This observations has also been made in the U.S. "Consumers don't seem to take advantage of the opportunities provided by a loan program simply because it's a 'good deal' " (Hayes et al., 2011, p. 6). Even though observed participation rates in the U.S. are significantly higher than the Green Deal's 0.006%, more than half of the programmes showed participation rates below 0.5% over their lifetime (Bell et al., 2011). It is remarkable that under PAYS® programmes, including How$mart®, more than 50% of approached customers have said *yes* offered efficiency improvements (H. Lachman, personal communication, various occasions). However, limited data is available on overall participation rates in the target population these programmes. The overall market penetration rate of How$mart® was 1.2% over the first three years (Cillo & Lachman, 2013). This suggests that establishing a first contact is still a major limitation to the scalability of on-bill programmes.

6.4.3 Limited applicability for those most in need

As mentioned before, estimated savings are not guaranteed. A significant rebound effect can be expected for households in fuel poverty that reduced energy use by sacrificing in-door comfort (Bell et al., 2011; Fuller, 2008). Here, net savings on the energy bill are unlikely to be achieved. For consumers with a very low disposable income, this leads to a higher risk of disconnection from utility services. This problem could be solved by requiring a higher safety margin between on-bill repayments and expected energy cost savings. Furthermore, additional financial support in form of grants could be provided for reducing the project costs.

7. Conclusion

The overarching aim of this thesis was to increase our knowledge on the critical factors that facilitate or inhibit the performance of on-bill programmes for energy efficiency improvements. The second more specific objective was to assess, if on-bill models could complement the Germany policy instruments mix for energy efficiency in an effective manner.

Addressing the first research question, identified *facilitating factors* for on-bill programmes are a streamlined programme design, concentrating on one or two sources of funding and relatively few contractual sequences. Placing a utility at the heart of the programme can be recommended for reducing administrative and transaction costs for a number of reasons. Utilities are able to build on-bill programmes on existing relationships to their customers and can apply targeted marketing strategies based on their customer data. Actively approaching potential customers was identified as essential for overcoming consumers' high levels of inertia. Furthermore, having one utility cooperating with a number of contractors can reduce costs through economies of scale, compared to a more open design where many auditors and installers set-up their own programme. Another crucial facilitating factor for overcoming barriers on the consumer's side is to design the on-bill product as a service. Consumer research has shown that a large majority of consumers is unwilling or unable to take out debt for financing energy efficiency measures. Furthermore, limiting eligibility criteria for programme participation to substantial energy cost savings is reasonable, if the payment obligation is tied to the building's meter. As the provider needs to be prepared for changing bill-payers over the payback period, the hassle related to checking the credit worthiness of the first consumer does not necessarily pay off in form of a higher degree of security. If these factors as well as substantial cost-effective energy saving potentials are given, on-bill models are able to overcome several of the traditional barriers to investments in energy efficiency.

Conversely, *inhibiting factors* are high administrative and transaction costs due to a complex programme design with a high number of actors and multiple sources of finance involved. It can be argued that structuring the product as a loan is detrimental for consumer up-take. A general limitation is that energy cost savings rarely allow to provide all involved actors, comprising the consumer, the auditor, installer, provider and lender, with monetary benefits. This situation might change in light of rising energy prices, the internalisation of negative externalities and a phase out of subsidies for energy carriers. However, it is unlikely that many purely market driven programmes will be implemented in the near future. Access to cross-subsidised low cost capital or other forms of government support seems to be needed to encourage market actors to voluntarily adopt on-bill models.

With regards to the second research question, it can be concluded that OBF could complement *Germany's policy instruments mix* in an effective manner. Highly cost-effective energy saving potentials could be leveraged that are neither addressed by energy minimum performance standards, nor by the KfW's soft loan programmes (excluding heating systems). If a new policy is based on the identified facilitating factors, OBF might be attractive for those consumers that are generally open for energy efficiency improvements, but who are not willing (1) or unable to take out a loan, (2) to accept risk related to residence periods shorter than payback periods and malfunctioning measures, and (3) to go through a significant hassle related to searching information about technologies and financing options.

The critical question might be if utilities will regard OBF as an opportunity to establish new business areas or as a threat to their conventional profit centre. Furthermore, in times of austerity it will be essential how banks evaluate the risk attached to this innovative financing model. Drawing in private capital will be a key factor for scaling up the future impact of OBF.

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Appendix

Annex I – Guidelines for conducted semi-structured interviews in chronological order

[General note: Interviews with Green Deal providers largely followed the survey design. Green Deal providers were asked for clarifications and to elaborate on mentioned obstacles and barriers related to the Green Deal. Therefore, no interview guidelines were included here. Communications with Michael Blohm followed no strict interview guidelines, as they were structured as an open discussion about OBF and OBR programmes. Many interviews were followed up by e-mail communications, which are also not presented here.]

Interview with a representative from the UK Department for Energy and Climate Change (DECC)

Date: March 6, 2014

Format: Skype

1. From an outsider perspective discussion around the green deal started in 2009. Who developed the idea of introducing the Green Deal?
2. One basic question, before going into the details - the types of measures that the government would like to see installed, like cavity or solid wall insulation, mostly reduce the energy consumption from heating. However, costs are recovered on the electricity bill, where the savings cannot be seen by the household. How does that go together with the concept of the Golden Rule?
3. The uptake of the green deal finance has been rather slow (1,700 instead of 10,000 during the first year). What are the main reasons in your opinion?
4. Would you regard the interest rate as a major barrier?
5. Context: Are people interested in deeper renovations of their homes?
6. Are people interested in the model of on-bill financing?
7. From going through available literature, I have understood that measures, such as external solid wall insulation or double glazing, can often be financed only partially through the Green Deal and might not yield a net benefit over a period of 25 years. Is that correct?
8. What kind of measures does the government aim to trigger with the green deal?
9. The government has announced changes to the green deal and ECO in December. What were the main motivations behind these proposed changes?

Interview with a Zoe Leader, Energy Efficiency Policy Officer at the WWF-UK, / Interview with Steven Heath, Director for Public Affairs at Knauf Insulation Northern Europe

Date: March 6 & 7, 2014

Format: Telephone

1. The WWF has been very active in the Great British Refurb Campaign. How happy were you with results of the campaign?
2. One basic question, before going into the details - The types of measures that the government would like to see installed, like cavity or solid wall insulation, mostly reduce the energy consumption from heating. However, costs are recovered on the electricity bill, where the savings cannot be seen by the household. How does that go together with the concept of the Golden Rule?
3. The uptake of the green deal finance has been rather slow (1,700 instead of 10,000 during the first year). What are the main reasons in your opinion?
4. Would you regard the interest rate as a major barrier?
5. Context: Are people interested in deeper renovations of their homes?
6. Are people interested in the model of on-bill financing?
7. From going through available literature, I have understood that measures, such as external solid wall insulation or double glazing, can often be financed only partially through the Green Deal and might not yield a net benefit over a period of 25 years. Is that correct?
8. Was the government using too optimistic assumptions when the Green Deal was designed?
9. The government has announced changes to the green deal and ECO in December. How do you evaluate these proposed changes?

Interview with Michael Volker, former Director of Regulatory and Energy Services at Midwest Energy, Inc.

Date: March 27, 2014

Format: Telephone

1. Could you tell me a bit more about your former role at Midwest Energy as the Director of Regulatory and Energy Services?
2. What are the most common measures installed under How$mart?
3. What are the measures with the highest investment costs installed?
4. Is the charge for repaying the service located on the electricity or gas bill?
5. How long do customers pay the charge on utility bill - as long as the measure functions or until the investment costs, programme fees and finance costs are paid off?

6. Do programme participants technically take out a loan?
7. Could I get access to the most recent data from the programme evaluation on (a) number and types of measures installed (split into types of measures), (b) Yielded energy savings, (c) Investments made, (d) Programme costs
8. Regarding the level of capital costs - Midwest Energy had access to low cost capital from federal programmes? Is this the reason why the interest rate is relatively low?
9. Has there been research carried out on transaction costs?
10. Is How$mart a programme to improve customer loyalty or a new strategic business area for Midwest Energy?
11. Is the How$mart programme profitable on its own? Is the incoming money flow compensating the losses in the sales of electricity and gas?
12. In your opinion, what are the success factors for the How$mart programme?
13. Are you familiar with the Green Deal? [If so, discuss performance and design.]

Interview with Reinhard Loch, Head of the Energy Efficiency Unit of the Consumer Association North Rhine-Westphalia (VZ NRW)

Date: June 13, 2014

Format: Face-to-face

Note: This interview was conducted in German.

1. Could you tell me a bit more about your role as the Head of the Energy Efficiency Unit of the Consumer Association North Rhine-Westphalia?
2. This research project is analysing so-called on-bill or Pay as You Save® programmes. Are you familiar with this concept? [If not, explain essential design features.]
3. Based on your experiences, do you think that on-bill models could be appealing to household segments that would normally not engage with energy efficiency programmes?
4. In the U.S., several utilities voluntarily introduced the Pay as You Save® programmes in their service area. We still have large energy saving potentials in Germany, but the market for energy efficiency services, such as energy-performance-contracting are still small. How do you explain that these models are applied in the U.S., but not here? [Discuss issue of transaction costs and capital costs.]
5. Do you see problems from a consumer protection perspective? [Discuss disconnection in case of non-payment.]
6. If policy-makers encourage the introduction of on-bill programmes, what would be your recommendations?

Interview with Frank Schillig, Managing Director at KWA Eviva GmbH

Date: June 16, 2014

Format: Face-to-face

Note: This interview was conducted in German.

1. Could you tell me a bit more about Eviva's activities in the contracting market?
2. This research project is analysing so-called on-bill or Pay as You Save® programmes. Are you familiar with this concept? [If not, explain essential design features.]
3. Do you think that on-bill models can overcome market barriers that are still persistent under conventional energy-performance-contracting models?
4. Energy-performance-contracting has been used for the modernisation of heating systems. Do you see areas that could be addressed by Pay as You Save® programmes?
5. Based on your experiences, do you think that on-bill models could be appealing to household segments that would normally not engage with energy efficiency programmes?
6. In the U.S., several utilities voluntarily introduced the Pay as You Save® programmes in their service area. We still have large energy saving potentials in Germany, but the market for energy efficiency services, such as energy-performance-contracting are still small. How do you explain that these models are applied in the U.S., but not here? [Discuss issue of transaction costs and capital costs.]
7. If policy-makers encourage the introduction of on-bill programmes, would this be an interesting business area for Eviva?
8. Assuming that policy-makers introduce an energy company obligation, could this be a facilitating factor for the energy service market?

2nd Interview with a representative from the UK Department for Energy and Climate Change (DECC)

Date: June 18, 2014

Format: Face-to-face

1. [Show figure of the customer's journey and ask if all key activities and contractual sequences are illustrated correctly.]
2. Who carries the risk if the measure breaks, e.g. who carries the costs of a broken boiler?
3. DECC publishes monthly statistics on the up-take of Green Deal financing plans and the installation of measures. Does the reported number of measures using Green Deal finance refer to measures that were only financed under the Green Deal or also to measures where Green Deal finance was blended with other sources of capital?

4. DECC's new study reported that the accreditation process for Green Deal providers was simplified. Could you provide me with more details how the accreditation process was simplified? Have you measured the effect of this simplification?
5. There seems to be an unwillingness amongst larger firms to use their own capital for investments under the Green Deal. Do you know why? Is the Green Deal perceived as risky?
6. In the Impact Assessment for the Green Deal and ECO, DECC estimated the costs of specific energy efficiency and renewable energy technologies. Have you compared the assumptions about the costs of the measures in the impact assessment as well as the Green Deal costs matched to current "real-life" prices?
7. Outlook: Based on the experience that you made here in the UK with developing a whole new Green Deal supply chain, which recommendations would you give to policy-makers in other countries that are interested in introducing a similar scheme?

Interview with a representative from the Green Deal Finance Company (GDFC)

Date: June 19, 2014

Format: Face-to-face

1. Could you tell me a bit more about the institutional background of the GDFC?
2. The Green Deal as a financial product, as an unsecured loan, is this correct?
3. What is the legal foundation for the transfer of the payment obligation to the next resident?
4. Who is liable if the consumer cannot pay or if the Green Deal provider goes bankrupt?
5. What kinds of guarantees are given to the consumer?
6. The interest rate has been criticised as too high. Can you explain how the GDFC arrived at the 6.95% p.a.?
7. Do you have ideas or recommendations how to reduce the capital costs?
8. Do you have ideas or recommendations how to reduce transaction costs attached to the Green Deal?

1st Interview with Kirsty Neale, a former employee at the UK Department for Energy and Climate Change (DECC)

Date: June 19, 2014

Format: Telephone

1. You worked for DECC when the Green Deal was designed. Could you tell me a bit more about your role in designing the Green Deal?
2. What were the major assumptions underlying the design of the Green Deal?
3. During the design phase, did you take a look at the on-bill programmes in the U.S.?
4. Have you considered to connect the Green Deal with the Energy Company Obligation and to obligate energy companies to offer on-bill programmes to their clients?
5. If you could start from the beginning with the design of the Green Deal, is there something you would do differently?
6. How could transaction costs be reduced?
7. How could the interest rate be reduced?

Interview with Jan Rosenow, Researcher and Senior Consultant at Ricardo-AEA Group

Date: June 24, 2014

Format: Telephone

Note: This interview was conducted in German.

1. How do you evaluate the general idea that underlies the Green Deal?
2. How do you evaluate its implementation?
3. Why was the level of ambition reduced so drastically (less than 1/3) compared to previous supplier obligations in the UK?
4. If you had the chance to introduce changes to the Green Deal, what would that be?
5. Discuss idea to connect the Green Deal with the Energy Company Obligation/ oblige energy companies to offer on-bill programmes to their clients? Recover costs from customers who benefit from energy efficiency improvements, instead of transferring the costs to all customers?
6. Are you familiar with on-bill programmes in the U.S.? [If not discuss programme design features, particularly offering the installation and financing of energy efficiency measures as a service.]

Interview with Harlan Lachman, Developer of the Pay as You Save® system at the Energy Efficiency Institute, Inc. (EEI)

Date: July 1, 2014

Format: Telephone

1. What are the main features of the Pay as You Save® system that have to be implemented to use the PAYS trademark?
2. I understand that both the landlord and the tenant have to give their consent. What I am not sure is who has the contractual relationship with the provider for the installation and financing of the measure?
3. Do you ask utilities that use the PAYS® system to calculate with a "rebound effect", when estimating energy savings?
4. I have read in your publication that more than 50% of those customers receiving offer in the residential PAYS® programmes decided to participate, however, overall participation rates are rather around 1%. How do these two numbers go together? Is PAYS® only offered to certain customers?
5. Do tariff based on-bill programmes show a higher performance compared to on-bill programmes which are based on a loan?
6. I have learned from the How$mart Program that Midwest Energy files a lien to the property. Is this in line with your PAYS® system? Doesn't this have a similar effect to a loan?
7. I have also learned about How$mart that Midwest Energy's costs are not fully recovered by the customers' payments on their bill. It is still attractive to the utility as they achieve a very high customer satisfaction, but they are cross-subsidizing it from other business areas. Do you know if there are efficiency programmes where are costs are fully covered by customers' payments?
8. Have you carried out evaluations of the transaction costs involved in providing PAYS® programmes?
9. I wonder why the PAYS® system works in the United States, but has not been implemented in Europe yet. Do you think there are major differences regarding (a) Energy saving potentials, (b) Transaction costs, (c) Capital costs, (d) Political conditions, (e) Mentality. What do you think about this?
10. In Germany, it is very common that heating expenses are covered in the rent, however, after a yearly check of the tenant's actual energy consumption he or she will get money back if the monthly payment in the rent was set too high and exceeded energy costs. I fear that in this situation the landlord does not have a real incentive to lower the properties' energy bills in a PAYS programme. What is your opinion on this issue?
11. About one third of the German buildings are heated with oil. There is no meter measuring the consumption, just an oil tank which needs to be refilled once a year. Could a PAYS® system work for these households?

12. Why do you think the Green Deal is not such a good deal for consumers?
13. Depending on the design of the PAYS® programme?
14. Who is the owner of the measure, e.g. a new boiler, until it is paid off?
15. How are the costs for an energy efficiency measure calculated, if it is part of a bigger renovation, e.g. a house will get a new facade anyway but the provider is only encouraging a better insulation?
16. Where are the benefits from lower energy bills located, if energy costs (both heating and electricity) are included in the rent? On the side of the landlord, the tenant or both?
17. As the payment is attached to the meter, not to the consumer - how can you make sure the obligation is legally transferred to the following owner? Is there an entry to some kind of property register?

Interview with Andreas Mucke, Director of the mini-contracting programme for efficient fridges, operated by the German local electricity provider Wuppertaler Stadtwerke (WSW)

Date: July 16, 2014

Format: Telephone

[Note: This interview was conducted in German.]

1. Could you tell me a bit more about the mini-contracting programme for efficient fridges, operated by the Wuppertaler Stadtwerke?
2. What kind of fridges do you offer?
3. Can you describe the process or customer's journey?
4. What are the overall costs of the mini-contracting programme and how are these cost distributed with regards to investments made in efficiency fridges and administrative, marketing and transaction costs?
5. Who is carrying the risk in case a fridge breaks?
6. How is the demand for the mini-contracting model from the customer's side?
7. Have you heard about Pay as You Save® programmes in the United States? [If not, explain the essential design features.]
8. Given that the legislator would provide a legal foundation, do you think a PAYS® programmes could be interesting for the Wuppertaler Stadtwerke?

2nd Interview with Kirsty Neale, a former employee at the UK Department for Energy and Climate Change (DECC)

Date: August 5, 2014

Format: Telephone

1. You explained that locating the liability for defaulting customers and Green Deal providers was a major problem. Where is the liability lying now?
2. Did you have the impression that energy companies are not willing to participate as it would interfere with their core business, selling electricity and gas?
3. What would you recommend to other countries that are interested in designing a policy instrument for on-bill models from scratch?

Annex II – Questionnaire for the "Survey on the Green Deal from a Green Deal Provider's Perspective"

Survey on the Green Deal from a Green Deal Provider's Perspective

The objective of the survey is to get information about the obstacles and barriers faced by Green Deal Providers. The outcomes will provide useful knowledge to better understand what are the major cost drivers that 'Green Deal Providers' face and what can be done to further facilitate the provision of Green Deal Plans to energy end-users.

This survey is part of a research project titled 'Policy Intervention for a Competitive Green Energy Economy', carried out at the International Institute for Industrial Environmental Economics at Lund University, Sweden

Your insights will be a highly valuable input for this research project It will help us to develop policy recommendations for the Green Deal and the design of future on-bill programmes across European countries.

Your input, including your name and the name of your company, will be confidential. All the figures will be aggregated. It will take you around 20 minutes to complete this survey.

You will receive the research results by October 2014. Please do not hesitate to contacts us in case of any question.

Thanking you in advance for your kind effort and important contribution to this research project.

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1. Which of these **Green Deal services** does your company offer? Please tick the boxes. Feel free to add further services related to the Green Deal provided by your company.

Service	
Arrange Green Deal assessment (with a third party)	
Carry out Green Deal assessment (in-house)	
Arrange installation of measures (with a third party)	
Carry out installation of measures (in-house)	
Green Deal Finance Plans	

2. When did your company **enter the 'Green Deal market'**?

2013 **2014**

Jan Feb Mar Apr May Jun Jul Aug Sept Oct Nov Dec Jan Feb Mar Apr May

3. What kind of **customer segments** have you served? Please indicate the share, for example of multi-family apartment buildings, out of all households you served by ticking the box. As the categories are overlapping, several groups might have a very high or very low share.

Customer group	**0-25%**	**26-50%**	**51-75%**	**76-100%**
Businesses				
Single-family dwellings				
Multi-apartment buildings (1- 3 units)				
Multi-apartment buildings (4-7 units)				
Multi-apartment buildings (8 or more units)				
Homeowners				
Tenants				

4. Please indicate the **number of households** that you provided with a Green Deal Plan (a). If the exact number is not easily available or confidential, please give an estimate by ticking one of the boxes (b).

   a) **Exact number:** ……

b) Estimate of No. of Green Deal Plans for	**0- 15**	**16 - 30**	**30 - 35**	**36 or more**
Energy efficiency installations				
Renewable energy installations				

5. Please indicate the **total capital costs** of all measures installed under the Green Deals Plans provided by your company. Capital costs include pure technology costs, as well as installation and construction labour costs. If the exact number is not easily available or confidential, please give an estimate by ticking one of the boxes (b).[49]

a) Exact number: ……

b) Estimate of total capital costs for	**Up to £ 30,000**	**Up to £ 60,000**	**Up to £ 90,000**	**More than £ 90,000**
Energy efficiency installations				
Renewable energy installations				

6. Please indicate the **aggregated energy savings of all energy efficiency measures** (over their lifetime) installed under the Green Deal Plans you provided. If the exact number is not easily available or confidential, please give an estimate by ticking one of the boxes (b).

a) Exact number: ……

b) Estimate of energy savings over lifetime of installed measures	**Up to 150,000 kWh**	**Up to 300,000 kWh**	**Up to 600,000 kWh**	**More than 600,000 kWh**
Energy efficiency installations				

[49] To provide greater clarity regarding the definition of „capital costs" this questions was later on changed to: „Please indicate the **total capital costs of all measures installed under the Green Deals Plans provided by your company**. Capital costs include pure technology costs, as well as installation and construction labour costs. Total capital costs refer to the total amount of money that was invested into the measures under your Green Deal Plans either by your company through Green Deal Finance, the consumer or Cashback. If available it would be very much appreciated if you provide this data in an disaggregated manner, e.g. under your Green Deal Plans £20,000 were invested through Green Deal Finance, £10,000 were invested by customers and £20,000 through Cashback or the Home Improvement Fund."

7. Did you face **general obstacles and barriers** to implementing energy efficiency measures under the Green Deal? Please tick the most relevant boxes. Feel free to add additional obstacles or barriers faced by your company.

Obstacles and barriers	
Lack of knowledge/information on the Green Deal	
Lack of developers/contractors	
Lack of interest or apathy of end-users	
Uncertainties about the performance of energy efficiency technologies	
High costs of energy efficiency technologies	
Uncertainty about the future development of the Green Deal	
Project implementation and operational risks	
Difficulties in establishing contacts with end-users	
Difficulties in establishing contacts with partners/ contractors	
Lack of access to capital or financing possibilities	
Difficulties in preparing relevant documents (project design, Green Deal advice report, Green Deal financing report, administrative procedures, etc.)	
Projects were not easily replicable	
Other barriers and obstacles/ other comments:	

8. Please give an estimate of the share of your **marketing costs** in relation to the capital costs of the measures installed under the Green Deal Plans you provided. Capital costs include pure technology costs, as well as installation and construction labour costs.[50]

Marketing costs: …… % of capital costs

9. Please give an estimate of the share of your **administrative costs**, such as accounting, in relation to the capital costs of the measures installed under the Green Deal Plans you provided. Capital costs include pure technology costs, as well as installation and construction labour costs. Note: If applicable to your company, please indicate costs for providing energy assessments separately (see question 12).

Administrative costs: …… % of capital costs

10. Please give an estimate of the share of other **transaction costs**, such as search for information or negotiations with end-users or contractors) in relation to the capital costs

[50] After carrying out semi-structured interviews with Green Deal Providers it was found that Green Deal Providers faced significant accreditation costs. To receive a better picture of the sources and scale of marketing, administrative and transaction costs, the formulation of questions 8-10 was changed to "running marketing/ administrative/ transaction costs". Providers were asked to provide information regarding transaction costs related to the accreditation process in the comment field.

of the measures installed under the Green Deal Plans you provided. Capital costs include pure technology costs, as well as installation and construction labour costs.

Transaction costs: …… % of capital costs

11. Please indicate which of the following activities you would consider as **major cost drivers**, e.g. in-house capacity building was associated with very high costs for the company.
    Feel free to add additional activities which are relevant to provide customers with an attractive product (other than the installation itself).

Activities	**Very high**	**High**	**Medium**	**Low**	**Very low**
Search for information about the Green Deal					
In-house capacity building					
Accreditation costs					
Search of partners/contractors					
Negotiation and agreement with partners/contractors					
Marketing					
Interaction with customers before finalisation of the Green Deal Financing Plan					
Interaction with customers after finalisation of the Green Deal Financing Plan					
Developing Green Deal Financing Plans					
Interaction with Green Deal Finance Company					
Interaction with end-users' energy suppliers					
Project documentation/internal management					

12. If your company provides **energy assessments** to end-users, please indicate the costs of the assessment itself as well as related administrative, marketing and transaction costs in relation to the capital costs. Capital costs include pure technology costs, as well as installation and construction labour costs.

Energy assessment: …… % of investment/ technology costs

13. Please indicate the **product specific programme costs** taking into account all kind of activities carried out besides the installation itself (such as administrative, marketing and transaction costs). For example, due to an underdeveloped supply chain and highly individualised customer demands the costs are particularly high for the measure XY. Feel free to add further measures installed by your company.

	Measure	**Very high**	**High**	**Medium**	**Low**	**Very low**
I N S U L A T I O N	Easy-to-treat Cavity wall insulation					
	Hard-to-treat Cavity wall insulation					
	Internal Solid Wall Insulation					
	External Solid Wall Insulation					
	Loft insulation					
	Flat roof insulation					
	Double glazing					
	Floor insulation					
	High performance doors					
	Hot water cylinder insulation					
	Draughtproofing					
H E A T I N G	Condensing gas boiler					
	Condensing oil boiler					
	Biomass boiler					
	Photovoltaics					
	Solar thermal panels					
	Air source heat pumps					
	Biomass boilers					
	Biomass room heaters					
	Heating controls upgrade					
	Flue gas heat recovery					
	Thylinder thermostat					
	Under-floor heating					
	Waste water heat recovery systems					
L	Lighting systems					

14. For the measures where you indicated very high product specific programme costs, please **explain what the major cost drivers are**.

……

15. By experience, which measures are able to meet the **Golden Rule** on their own and which ones need an additional capital injection from the end-user (please tick the corresponding box). Feel free to add further measures installed by your company.

	Measure	**Meets the Golden Rule**	**Meets the Golden Rule only with investment of end-user**
INSULATION	Easy-to-treat Cavity wall insulation		
	Hard-to-treat Cavity wall insulation		
	Internal Solid Wall Insulation		
	External Solid Wall Insulation		
	Loft insulation		
	Flat roof insulation		
	Double glazing		
	Floor insulation		
	High performance doors		
	Hot water cylinder insulation		
	Draughtproofing		
HEATING	Condensing gas boiler		
	Condensing oil boiler		
	Biomass boiler		
	Photovoltaics		
	Solar thermal panels		
	Air source heat pumps		
	Biomass boilers		
	Biomass room heaters		
	Heating controls upgrade		

16. Does your company work with other **financiers** than the Green Deal Finance Company? If this is the case, please indicate what kind of financial sources you use.

……

17. If you had the chance to introduce **changes to the Green Deal**, what would you do? For example, simplify the accreditation process for Green Deal providers.

……

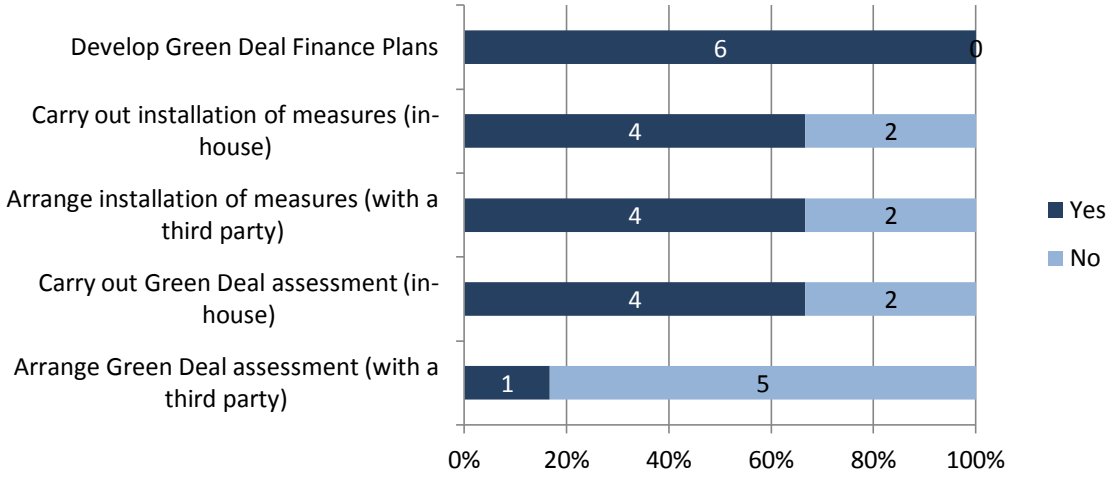
18. Did your **customers** give you **feedback** on how to improve the Green Deal to better meet their demands? For example, introduce more flexibility for early repayments.

……

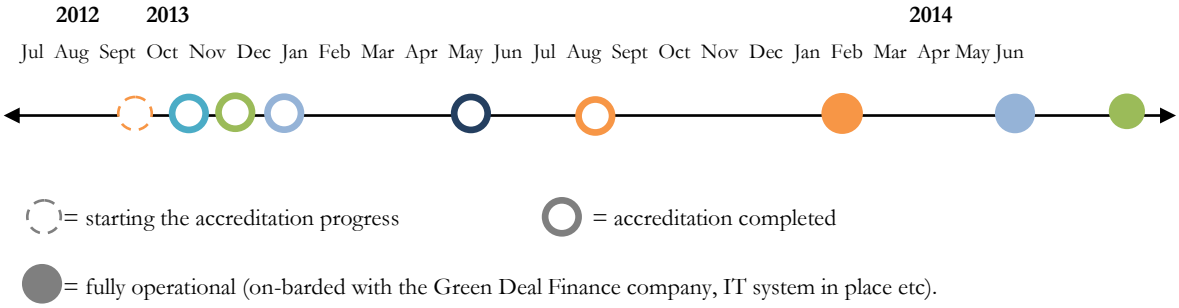
Annex III – Results of the "Survey on the Green Deal from a Green Deal Provider's Perspective"

Note to the reader: In total six Green Deal Providers have participated in the survey. As not all Providers responded to each question there are often less than six reported responses. Visualisations have been the preferred way of presenting the results of the survey. However, where values with a span from X to Y or up to Z were reported, tables were used instead.

1. Offered Green Deal Services by Green Deal providers



2. Point of time when the company entered the 'Green Deal market'



3. Shares of served customer segments by Green Deal providers

	Businesses	Single-Family Dwellings	Multi-appartment buildings (1-3 units)	Multi-appartment buildings (4-7 units)	Multi-appartment buildings (>8 units)
Provider 1	0-25%	76-100%			
Provider 2		76-100%			0-25%
Provider 3		51-75%	25-50%		
Provider 4	0-25%	51-75%	51-75%	51-75%	51-75%
Provider 5		51-75%			0-25%

	Homeowners	Tenants
Provider 1	51-75%	0-25%
Provider 2	25-50%	51-75%
Provider 3	25-50%	25-50%
Provider 4	76-100%	25-50%
Provider 5	76-100%	

4. Number of Green Deal plans sold to households

	Exact number	No. Green Deal plans for energy efficiency installations	No. Green Deal plans for Renewable energy installations
Provider 1	35	16-30	0-15
Provider 2	<50	16-30	0-15
Provider 3	n.a.	0-15	n.a.
Provider 4	n.a.	0-15	0-15
Provider 5	23	16-30	0-15
Provider 6	4	n.a.	n.a.

5. Total capital costs of all measures installed under the Green Deals plans sold by the responding Green Deal provider

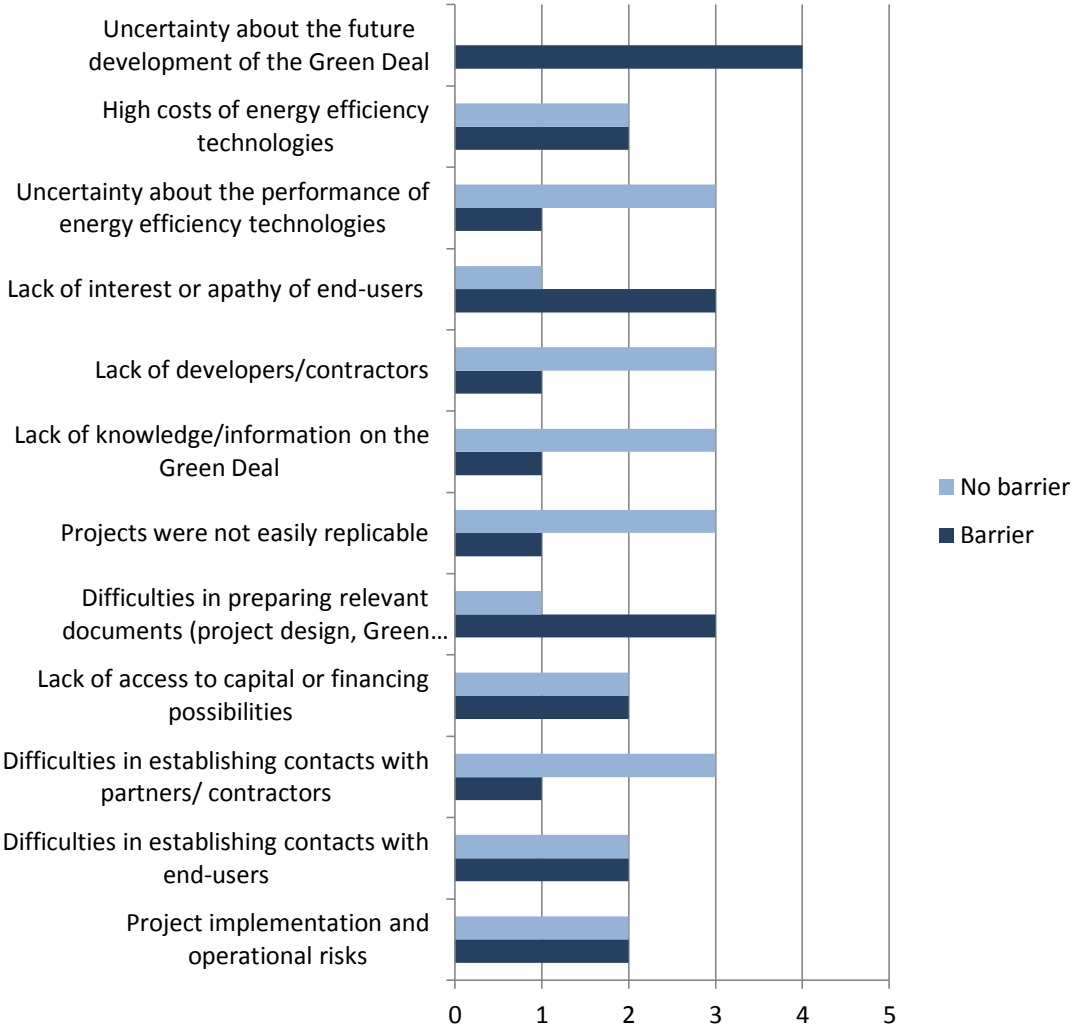
	Total	For energy efficiency installations	For renewable energy installations
Provider 1	Up to £ 90,000	Up to £ 60,000	Up to £ 30,000
Provider 2	Up to £ 60,000	Up to £ 60,000	-
Provider 3	Up to £ 60,000	Up to £ 30,000	Up to £ 30,000
Provider 4	£ 33,000 - 55,000	n.a.	n.a.
Provider 5	£ 33,400	n.a.	n.a.

Note: It was aimed to clarify with the respondents that total capital costs were defined as the total amount of money that was invested into the measures under the Green Deal Plans - either by the Green Deal Provider through Green Deal Finance, the consumer or Cashback. As responses revealed that Providers applied different interpretations of the term total capital costs, all providers were contacted again and asked for clarification. Unfortunately, no clarification was received from Provider 2 and 3. Therefore, the collected data and particularly comparisons between the reported data should be treated with care.

6. Aggregated energy savings of all energy efficiency measures (over lifetime) installed under Green Deal plans sold by the responding Green Deal provider

	Energy savings (over lifetime)
Provider 1	Up to 150,000 kWh
Provider 2	Up to 300,000 kWh
Provider 3	Up to 150,000 kWh

7. General obstacles and barriers to implementing energy efficiency measures under the Green Deal faced by Green Deal providers



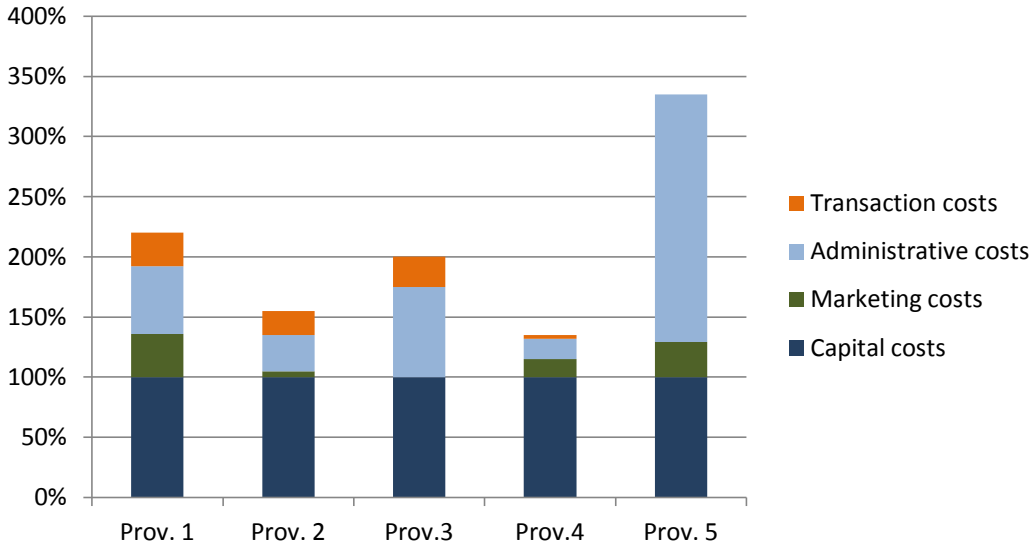
Comment:

- *"Main obstacles have been:*
  - *Time taken to complete paperwork and technical requirements for GD ORB and, especially, GDFC.*
  - *Constant changes made by Government to GD and ECO leading to uncertainty and lack of momentum*
  - *Lack of finance available (GDFC is the only option; expensive and time-consuming processes to access their finance, and prohibitive interest rate for end customer).*
  - *Cost and delays to implementation of IT solution (eTech) - used by most of the 'Big Six' and Ofgem, so obvious choice, but not fit-for-purpose at point we purchased it."*

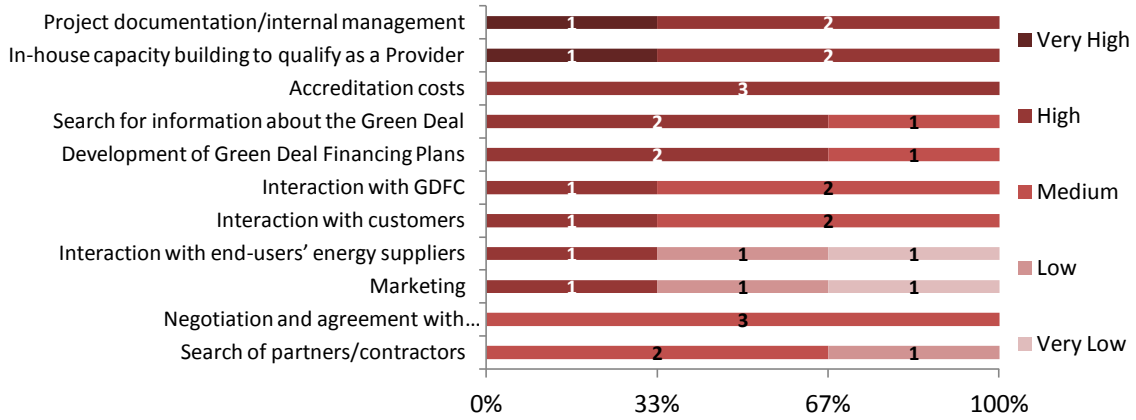
8-10. Estimate of marketing, administrative and transaction costs in relation to capital costs of the measures installed under Green Deal plans provided by responding Green Deal providers

	Prov. 1	Prov. 2	Prov.3	Prov.4	Prov. 5
Marketing costs	36%	5%	0%	15%	29%
Administrative costs	56%	30%	75%	17%	206%
Transaction costs	28%	20%	25%	3%	0%

Note: It was aimed to clarify with the respondents that total capital costs were defined as the total amount of money that was invested into the measures under the Green Deal Plans - either by the Green Deal Provider through Green Deal Finance, the consumer or Cashback. As responses revealed that Providers applied different interpretations of the term total capital costs, all providers were contacted again and asked for clarification. Unfortunately, no clarification was received from Provider 2 and 3. Therefore, the collected data and particularly comparisons between the reported data should be treated with care.



11. Major cost drivers faced by Green Deal providers when selling Green Deal plans

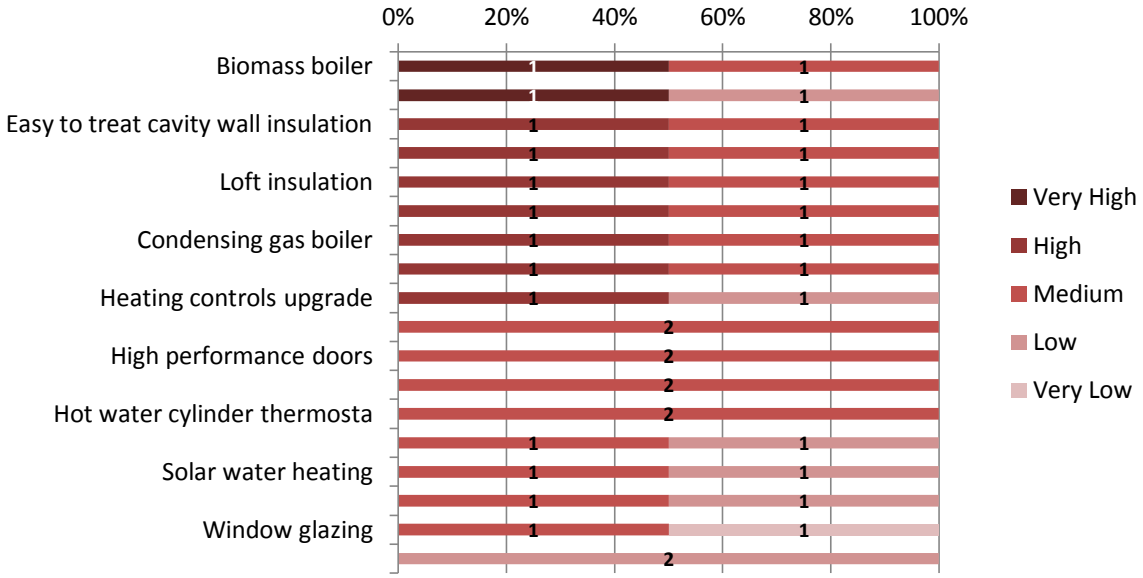


Comments/ other cost drivers: IT development, marketing, lawyer's fees, travel costs

12. Costs of energy assessments itself as well as related administrative, marketing and transaction costs in relation to total capital costs.

	Provider 1	Provider 2
Assessment	10%	3%

13. Product specific programme costs taking into account all kind of activities carried out besides the installation itself (such as administrative, marketing and transaction costs) faced by Green Deal providers

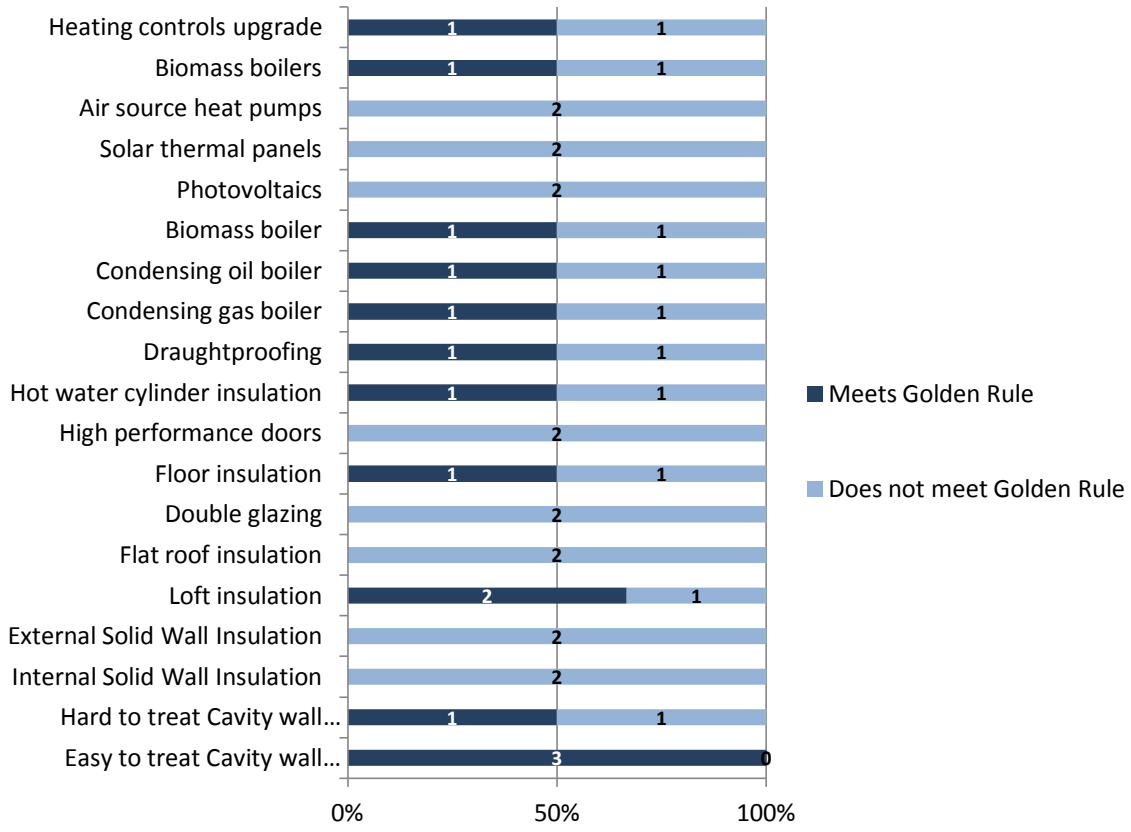


14. Cost drivers for measures with relatively high product specific programme cost

Comment:

– *"Measures which need high individualised advice: complicated heating solutions, hybrid solid wall insulation***"**

15. Evaluation of measures that meet the Golden Rule on their own (energy cost savings exceed repayments)



Comments:

- *"Insufficient experience to comment on all, but only very low cost measures such as ETT cavity wall and loft insulation are able to be fully funded"*
- *When customers heated with fireplace and changes to central heating, in 95% the Golden Rule does not work*

16. Green Deal providers with alternative sources of finance besides Green Deal Finance Company

- *"Not yet, but about to start relationship with a local Credit Union"*
- *"Blending Cashback with Green Deal Finance; seeking alternative finance providers (upcoming Barkleys finance product) to top-up on the Green Deal Finance for measures which can't"*
- *Access to ECO funding from British Gas, bilateral as well as brokerage*

17. Recommendations for improving the Green Deal from the Green Deal providers' perspective

- *"Simplify the red tape for the consumer"*

- *"Too many to mention! Completely change it from the start - ECO should only be used to support whole-house retrofit, in conjunction with GD where appropriate. Financing should be Government-funded, at a very low interest rate (i.e. 2%) to maximise take-up. Strict efficiency targets should be set (i.e. minimum EPC ratings) for owner-occupiers and landlords, to ensure participation and bring the most inefficient homes up to a better standard. etc..."*
- *"Relax the Golden Rule to allow more measures to meet the requirements, reducing the amount of customer contribution needed."*
- *1) lower the interest rate, 2) GD Home Improvement Fund is fantastic, 3) lack of consumer awareness*
- *"There need to be a simplified process for the end user, but still need to protect."*

16. Recommendations for improving the Green Deal from the customers' perspective

- *"Just that it took too long and understanding the process"*
- *"Lower interest rate. Make it easier to understand."*
- *"Streamlining the paperwork process"*
- *Happy with new cashback scheme; make lower interest; make it simpler*

Annex IV - On-bill financing (OBF) programmes in the United States based on the Pay as You Save® system

State	Utility	OBF Programme
California	Municipal Water Utility of the Towns of Windsor	Windsor Efficiency PAYS®
	Municipal Water Utility of the City of Hayward	Green Hayward PAYS®
Hawaii	Hawaiian Electric Company	Solar$aver
	Maui Electric Company, Ltd.	"
	Hawaii Electric Light Company, Inc.	"
Kansas	Midwest Energy, Inc.	How$mart®
Kentucky	Big Sandy RECC	How$martKY
	Fleming-Mason RECC	"
	Grayson RECC	"
	Jackson Energy	"
New Hampshire	Public Service of New Hampshire	SmartSTART *(expired)*
	New Hampshire Electric Cooperative	SmartSTART

Source: H. Lachman (personal communication, September 2, 2014); Cillo & Lachman (2013)

Annex V - Overview over the provisions under the three components of the UK Energy Company Obligation

	Component 1: **Carbon Saving Obligation (CERO)**	**Component 2:** **Carbon Saving Communities Obligation (CSCO)**	**Component 3:** **Affordable Warmth**
Targets for[51]	Emissions reduction:	Emissions reduction:	**Heating cost reduction:**
1) March 2013	4.18 $MtCO_2$	1.36 $MtCO_2$	**£0.84bn**
2) March 2014	8.36 $MtCO_2$	2.72 $MtCO_2$	**£1.68bn**
3) March 2015	8.36 $MtCO_2$	2.72 $MtCO_2$	**£1.68bn**
[extend to March 2017]	*[reduce level of ambition by 33%]*		
Household segment	All households	15% most deprived areas measured on the English, Welsh and Scottish indexes of Multiple deprivation *[extend to 25%]*	**Consumers living in private tenure properties that receive particular means-tested benefits**
Eligible measures	Solid wall and hard-to-treat cavity wall insulations[52] *[include loft insulation and easy-to treat cavity walls, but min. 100,000 solid wall insulations delivered by 2017]*	All insulation measures	**Heating and insulation measures**
Funding (annually)	**£760 million**	**£540 million**	

Source: Based on data from gov.uk (2014) and Stanger (2013)

[51] Phase 1: 1st January to 31st March 2013, Phase 2: twelve months ending with 31st March 2014, Phase 3: twelve months ending with 31st March 2015 (The Electricity and Gas (Energy Companies Obligation) Order 2012).

[52] In properties where solid walls or hard-to-treat cavity walls insulations are installed, energy suppliers are allowed to deliver additional measures which reduce the heat loss, such as loft insulation, efficient glazing or draught proofing, under the Carbon Saving Obligation (DECC, 2012d)