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Map of Policies Supporting Thermal Efficiency in Germany's Residential Building Sector

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Descriptors

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Executive Summary

The German government aims to reduce primary energy demand by 80% until 2050 and heating demand by 20% until 2020. Besides the need for additional efforts to achieve these targets, Germany has already implemented a set of policies and programmes to increase investments in thermal energy efficiency. This paper provides an overview of currently implemented German policies, specifically addressing two questions:

A) What roles do different types of policies play in supporting energy efficiency in the residential building sector and how do they interact?
B) In Germany, which policies fulfil these roles? How do they perform?

The report covers all main federal policies in Germany and reviews the current literature on the impact of the individual policy tools. The following summarizes the paper's key points:

A) What roles do different types of policies play in supporting thermal energy efficiency investments and how do they interact?

There are three key categories of energy efficiency policies for buildings in Germany:

i) financial instruments to improve the economics of thermal energy efficiency measures,
ii) information instruments to highlight advantages and options for investing into energy efficiency, and
iii) standards mandating performance requirements.

Interactions among these policies impact their overall effectiveness. Building policies are complementary because they fulfil different roles and respond to different needs; a single program is often not effective without the support of other mechanisms. For instance, for a loan or financing instrument to work, information instruments are needed to communicate the additional savings they offer. Applications to a programme with the same financial benefits can be increased manifold by alterations to the information provided. Equally, financial support programs increase the interest in and relevance of information instruments to building owners.

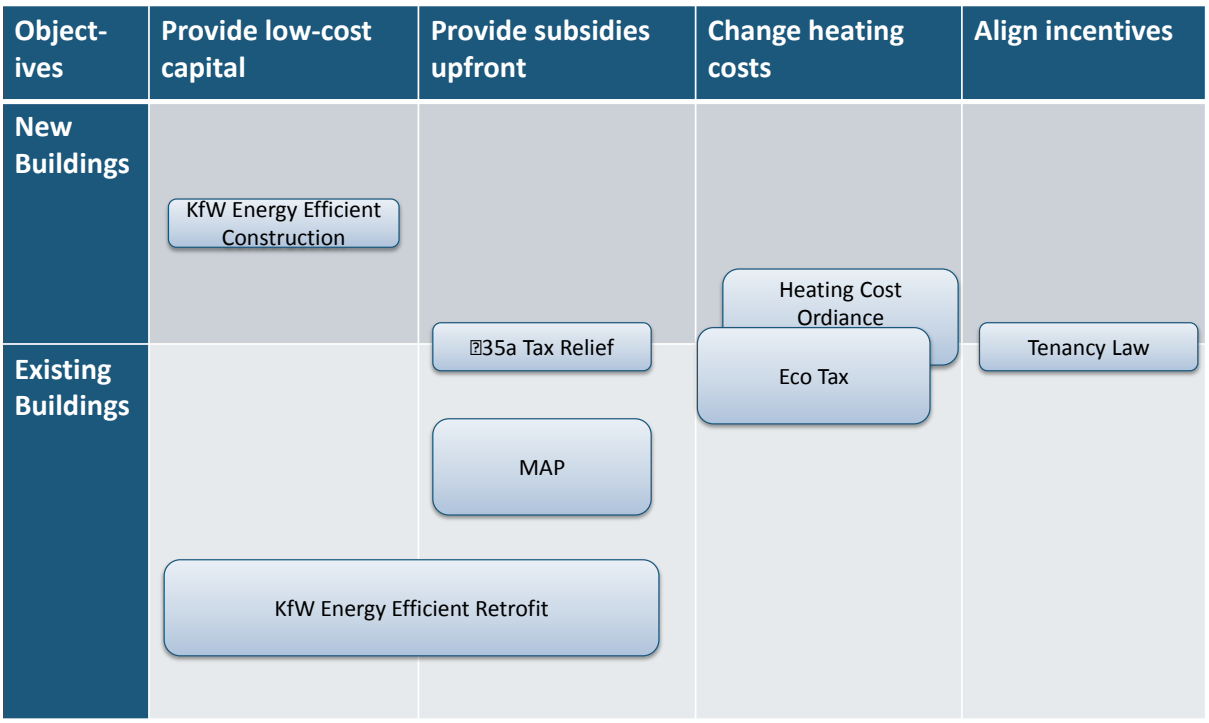
Besides the needs for a balanced policy mix, some policies can also act as substitutes to each other. Energy demand reductions can, for example, be either triggered by enhancing the profitability of energy efficiency technologies through financial support or by compulsory performance standards, depending on the policy preference of a government.

B) In Germany, which policies fulfil these roles? How do they perform?

Note: The charts below for each type of policy list key policies in Germany. Detailed descriptions of each policy are found in this paper.

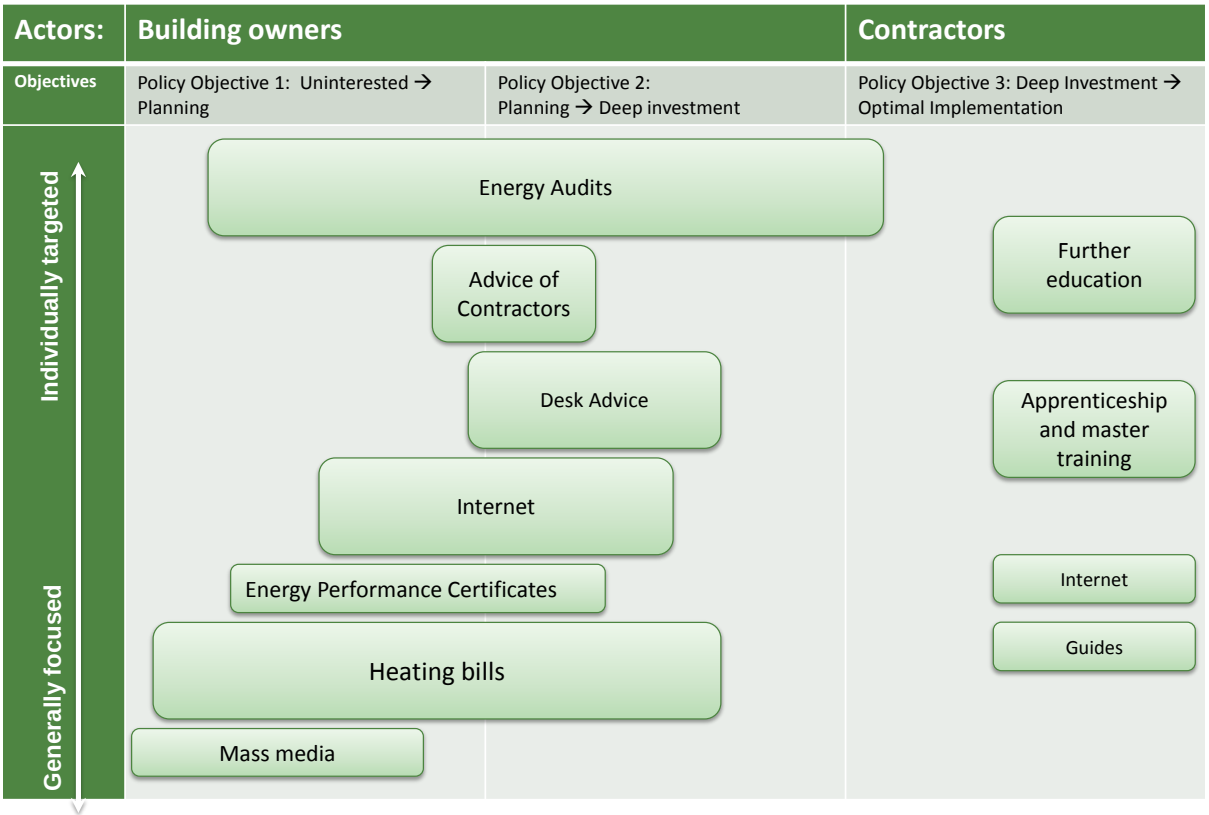
I. Financial policies

improve the economics of investments by addressing different needs and preferences of building owners. The following chart lists German policies that improve the economics of energy performance investments by either providing access to preferential finance or upfront support, changing heating costs, or aligning incentives. A diversity of financial support mechanisms is suggested to increase the impact of financial support because different actors prefer and/or need different support mechanisms.



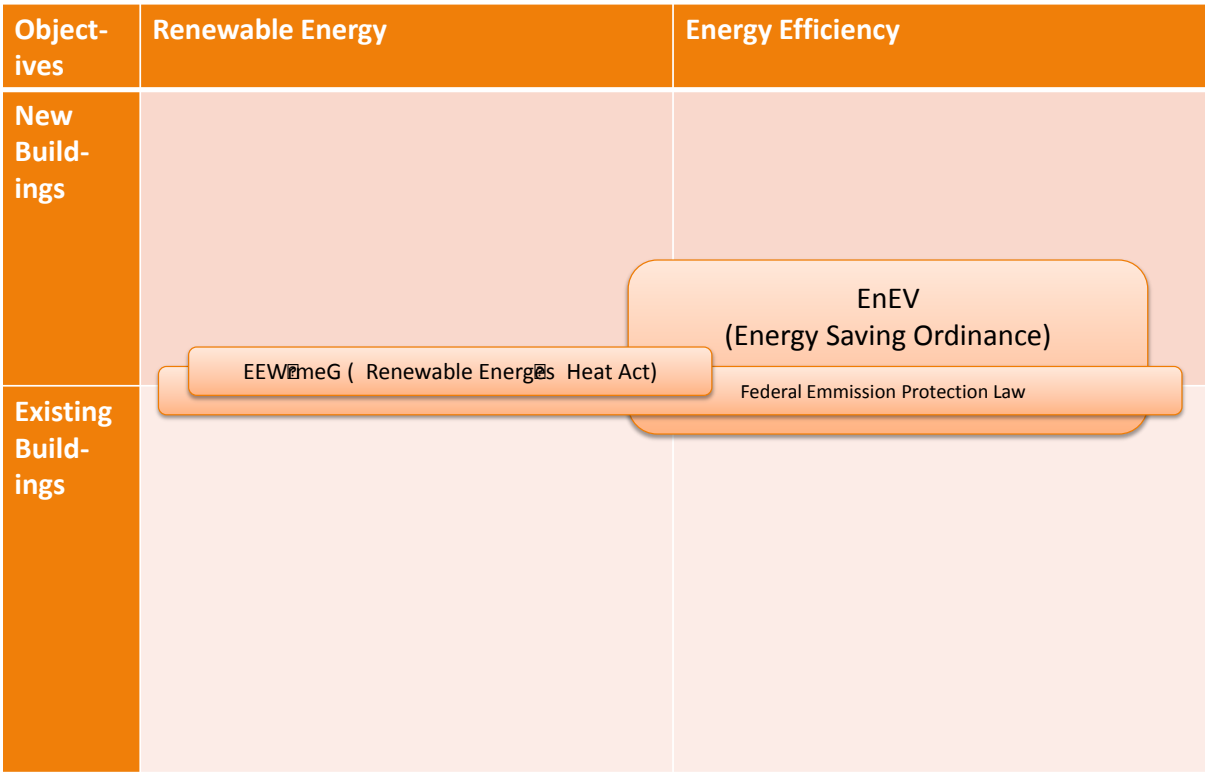
II. Information polices

support building owners in their decision on retrofits. They help uninterested actors to consider planning an energy efficiency investment by building awareness of benefits and help actors that are already interested in energy efficiency investments to develop their plan by offering information on different investments options. In addition, information instruments support contractors in the optimal implementation of and advice on energy efficiency technologies.



III. Standards

can address building owners that have large inertia for investing into the energy demand reductions of dwellings, despite economic and non-economic advantages and sufficient information instruments.



The main building standards, EnEV (Energy Savings Ordinance) and EEWärmeG (Renewable Energies Heat Act), predominantly focus on new constructions. The effort to define standards for thermal retrofits of existing buildings have to date resulted in a focus on financial and information instruments.

Introduction

According to the German Energy Concept, the building sector will play a lead role in reducing primary energy consumption. By 2050, the sector is prescribed to decrease primary energy demand by 80% by: reducing heating demand by 20% until 2020; ensuring all new buildings are climate neutral by 2020; and increasing the thermal retrofit rate from 0.8% to 2% (BMWi 2010; IWU/BEI 2010).[1] In order to achieve these aims, the German government is expected to strengthen existing instruments and introduce additional policies.

This paper describes the current landscape of policy instruments for residential buildings in Germany that support investments into thermal energy efficiency. The goal is to provide the reader with an easily accessible picture that addresses the questions:

A) What roles do policy instruments play in the building sector?
B) In Germany, which policies fulfil these roles? How do these policies perform?

German policies fulfil three key functions for supporting energy efficiency investments:
i) improve the economics of energy efficiency (financial instruments), ii) highlight the advantages of energy efficiency investments or the disadvantages of not investing (information instruments), and iii) regulate minimum performance requirements (performance standards).

A mix of these policy instruments helps to address different needs and to increase investments into energy demand reductions effectively:

1. Financial instruments are needed for example because households frequently discount the future higher than professional market investors (Sanstad and others 2006), despite the often beneficial nature of deep retrofits when they are combined with general modernisations (Neuhoff and others 2011a). As a consequence, financial support policies can help to increase interest into energy demand reducing investments that are only profitable in the medium term and can motivate building owners to pursue investments they would not have conducted without such support (Novikova and others 2011b). It is suggested to be beneficial to offer a diversity of financing mechanisms (grants vs. preferential loans vs. tax incentives) because different owners might prefer different forms of financial support (Stern and others 1986).
2. However, without information instruments, building owners will not be aware of the financial and non-financial benefits of investments into the energy performance of buildings. Evidence from a marketing experiment in the US suggests that the appeal to a programme offering incentives for retrofits was increased by a factor of five by minimal changes to letters sent to building owners as advertisement strategies (Stern 1999). Further, several studies have found that building owners often struggle to understand a) the benefits of retrofits b) the various technological options and c) which contractors[2] are sufficiently educated to implement an investment optimally (Novikova and others 2011b; Stieß and others 2010). Information instruments can increase both interest and the competence of building owners to choose the right investment options effectively (Novikova and others 2011a).
3. Standards that demand minimum performance requirements can help to address building owners that remain unaware of the financial and non-financial benefits of investments into the energy performance of dwellings.

Besides the needs for a balanced policy mix, some policies can also act as substitutes to each other. Energy demand reductions can, for example, be either triggered by enhancing the profitability of

[1] Currently, 0.8% of the building stock is retrofitted each year with an insulation of the outer wall.
[2] Or craftsmen in British English.

energy efficiency technologies through financial support or by compulsory performance standards, depending on the policy preference of a government.

The above distinction among the three types of information instruments (financial, information, performance standards) will be used as a structure to describe the German building energy policy landscape. In each section, the respective instrument type is further defined according to the policy objective which it addresses.

Policies that decrease primary energy demand through renewable heat are also included, if they primarily focus on supporting building owners to invest. However, the main focus of this paper is on efficiency policies.

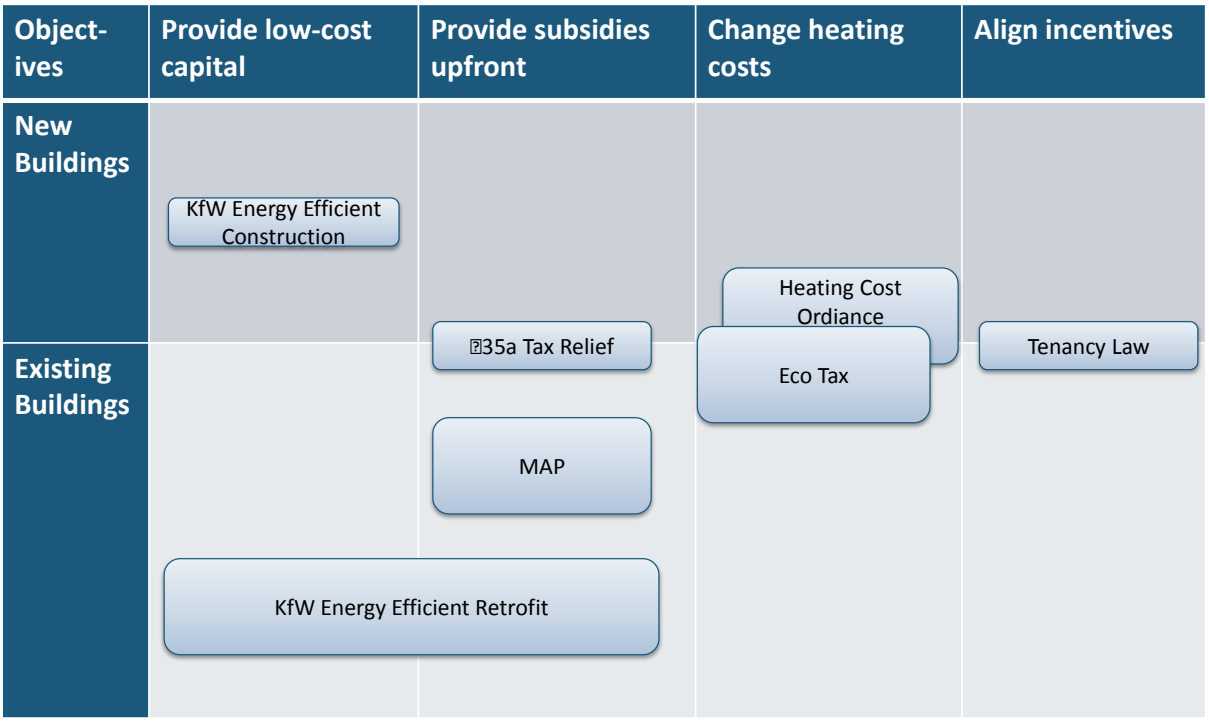
2 Policies that provide financial incentives – The Carrots

The goal of financial instruments is to improve the economics of investments into energy demand reductions of buildings. To achieve this, financial instruments can provide incentives through different mechanisms in order to cater for different needs and preferences. These can be clustered into four main categories:

- *Provide low-cost capital:* Energy efficiency investments, despite their favourable medium term economics, usually demand considerable upfront costs (Neuhoff and others 2011a). Low interest loans can therefore act as incentives to bear these high upfront costs.
- *Upfront support to create interest*: Actors with sufficient capital can be more attracted to energy efficiency investments by upfront grants than by preferential loans.
- *Change heating costs:* Policies that influence energy costs improve the economics of energy demand reductions and decrease the economics of the status quo.
- *Align incentives:* Often, landlords cannot capture all the benefits of their investments because they cannot pass their costs through to tenants.

Figure 1 maps the financial instruments in Germany targeting the above policy objectives. The instruments are described in detail below.

Figure 1: Financial instruments and their role in supporting energy demand reducing investments in residential buildings in Germany. The height of the boxes indicates high or low impact.[i]



2.1 Provide low-cost capital & upfront support

KfW Energy Efficient Construction, Energy Efficient Retrofit, and related programs

The German *KfW Bankengruppe* (Kreditanstalt für Wiederaufbau Bankengruppe = credit institute for reconstruction) is a publicly owned bank (80% owned by the German federal government and 20% by Länder/States) that acts as an implementing institute for various governmental financial programmes by offering preferential loans[ii], grants, and other forms of support. In 2010, the total volume of support

was 81,000 million EUR[iii] (KfW-Bankengruppe 2011a), of which 18,000 million EUR was associated with its programme *Wohnen* (habitation programme) (2011). Under the *Wohnen* umbrella, the total volume of support supplied by the *Energieeffizient Bauen* and *Energieeffizient Sanieren* programmes was 9,000 million EUR in 2010 and supported almost a million dwelling units (KfW-Bankengruppe 2011a).[iv] These programs comprise:

- *Energieeffizient Bauen* (energy efficient construction) provides preferential loans including a loan relief for new residential buildings that significantly surpass the building standard.
- *Energieeffizient Sanieren* (energy efficient renovation) provides preferential programs including loan reliefs or grants for retrofits of residential buildings that achieve a low primary energy demand level. The program also provides support for single energy efficient components.

The specific conditions of the loans and grants become the more favourable the better the energy standard achieved.[v] [vi] Further, several *Länder* programmes additionally lower the interest rates provided by KfW.

Conceptually, the KfW programmes are an effective tool in promoting savings due to their scale, their main focus on comprehensive primary energy reductions, the fact that financial barriers are one of the main obstacles undermining energy demand reductions in the building sector, and the social and technological learning effects which thermal retrofits and new construction programmes achieve. Evaluations studies have attributed a high impact to the programme, especially for existing buildings (Clausnitzer and others 2010; Matthes and others 2009). However, despite the size, international appeal and potential impact of KfW programmes, there have been few *ex-post* reviews of the programmes' total additional impact. Also, there has been little research on what type of financing (grant vs. loan and at various support levels) has the highest impact (Neuhoff and others 2011b).

MAP (Marktanreizprogramm Erneurbare Energien - Market Incentive Programme Renewable Energies)

One component of MAP provides grants through BAFA (*Bundesamt für Wirtschaft und Ausfuhrkontrolle* – the federal office for the economy and export control) to support small scale installations of renewable energy heating systems. The size of the grant depends on the scale of the installation and on the type of heating system.[vii] In 2009, this programme received approximately 250,000 applications and supported installations with a total financial volume of 374 million EUR. Of these, 163,000 installations were solar thermal systems, 60,000 solid biomass systems, 28,000 heat pumps, and 1,400 innovative solar and biomass systems (BAFA 2010). Since 2009, MAP has been part of the *EEWärmeG* support mechanism. This mechanism will provide up to 500 million EUR annually in financial support for renewable-based heating in buildings from 2009 till 2012 (§ 13, EEWärmeG). MAP is evaluated to have a high impact (Matthes and others 2009; MURE 2011).

§35a

For owner-occupied dwellings, *§35a* of the income tax law (EStG) allows households to deduct 20% of labour costs of retrofits from their taxes. This can also be used to cover costs of thermal retrofit and comprises a support value of up to 1,200 EUR per year which cannot be combined with KfW energy efficiency programs. The program does not have a high impact on energy demand as it is not targeted at thermal energy related measures (Weiß and Vogelpohl 2010).

2.2 Change heating costs

Heating Cost Ordinance

The main instrument that improves the economics of energy demand reducing investments is the *Heizkostenverordnung* (heating cost ordinance). The ordinance, which was enacted in 1981 in the old

Länder and in 1996 in the new Länder, demands the metering and pricing of heating according to the actual consumption (at least in parts) in buildings with a central heating system (§ 4, 5, 6, HeizkostenV). The effect of the policy has not been evaluated comprehensively, but according to IEA estimates, exposure to costs of energy use results in energy efficiency effects of about 15%, without negative impact on comfort (MURE 2005).

Eco Tax

The second cross-cutting policy instrument is the *Ökosteuer* (eco-tax). The Ökosteuer, which taxes energy inputs, was enacted in 1999 and has since then been successively increased. IRE/Prognos, Kohlhaas as well as Knigge and Görlich have evaluated a high impact of the eco tax reform for saving final energy and CO_2 emissions (IER/Prognos 2004 ; Knigge and Görlach 2005; Kohlhaas 2005). Yet, Bach argues that the tax reform has only been responsible for a small share of energy demand reduction for the building sector because heating fuels were only taxed to a limited extent and the biggest price increases were not due to the tax itself but due to rising fuel prices (Bach 2009). Weiß and Vogelpohl add that the effect of the tax reform has decreased over time due to continuously increasing prices for fuels on the world market (Weiß and Vogelpohl 2010).

2.3 Align Incentives

Tenancy Law

The current German tenancy law is not a policy which specifically supports investments in energy demand reductions of existing buildings. However, the policy does impact incentives in the rented building space (58% of dwellings in Germany) and is currently under political revision, so we have included it here (Statistisches Bundesamt 2011).

§ 558 BGB allows landlords to raise the rent up to the local comparative rent (*Ortsübliche Vergleichsmiete*), but by no more than 20% in three years. However, for modernisation activities that increase the living standard or save energy, § 559 enables landlords to increase the rent by 11% annually until the modernisation costs have been reflected in the rent (up to the comparative rent).

The current regulation has the following problems: First, the pass-through of costs is limited through binding possible rent increases to the local comparative rent, which might not take into account energy efficiency aspects. Second, currently landlords are concerned that tenants demand a rent reduction during the modernisation activities.

3 Policies that provide information - The Tambourines

Retrofitting decisions and implementations are described and perceived as a complicated process. Information instruments can support actors in their decision making by focussing on three objectives, derived from a survey analysing the decision making steps of owners of single and two-family houses (Novikova and others 2011b):

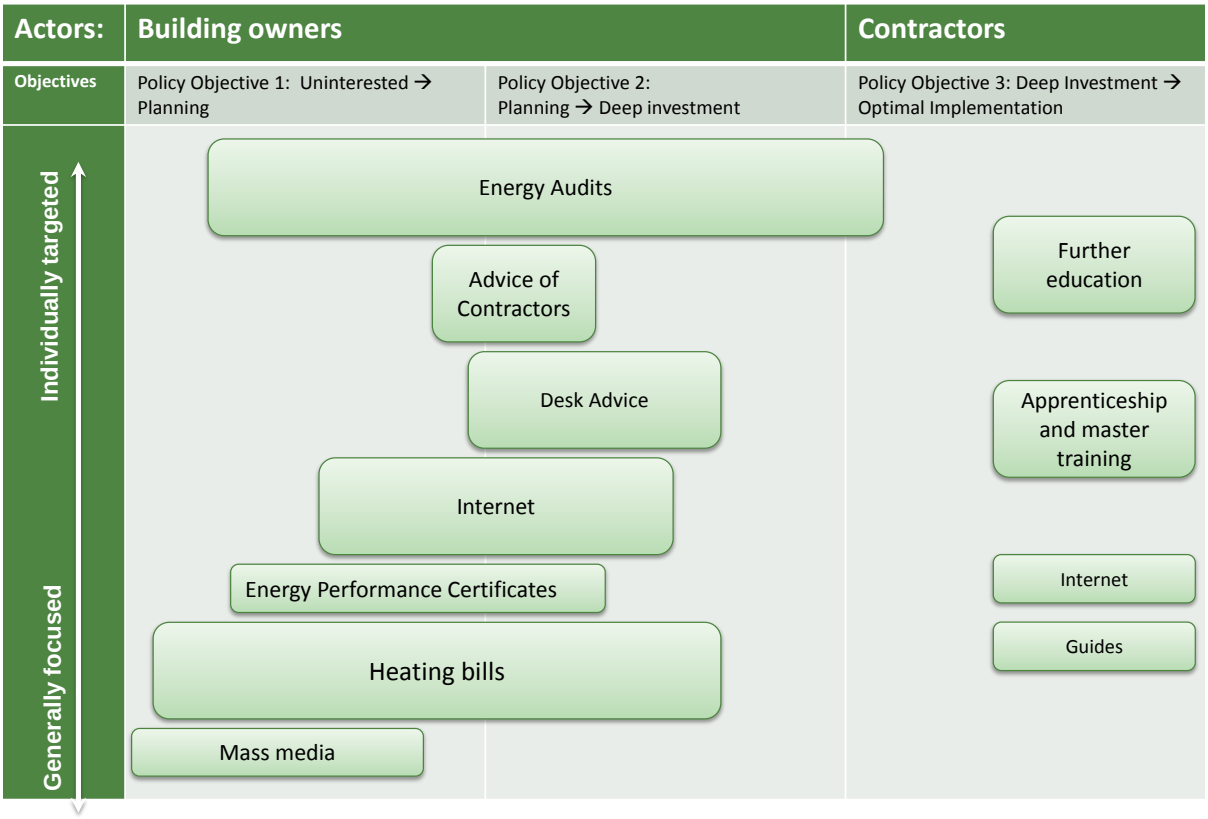
- First, a set of policies aim to move owners not yet interested in energy efficiency investments to a stage where they actively consider such an investment (from an "uninterested" to a "planning" stage). However, uninterested actors are not actively searching for information, so information needs to be made available to actors in such a way that they "stumble across them."
- Second, policies can help to move already interested building owners to a stage where they purse an investment into energy reductions (from a "planning" to an "action" stage). This objective can be achieved by offering information about the performance of different investment options according to criteria relevant to the owner (e.g. economic/ comfort/

ambient). The recipients of this information are often proactive in seeking this information, so information instruments can demand some level of search activity by the owner.

- Third, policies exist that can support contractors in effectively contributing to the decision making process and effectively implementing the measures.[viii] This requires technical skills to implement energy efficiency measures and communication skills to provide advice and justifications for these investments to building owners. Information instruments supporting contractors consist of training and information programs.

The following policy map lists information instruments that support these policy objectives[ix] along the decision-making process (figure 2).

Figure 2: Information instruments and their role in supporting energy demand reducing investments in residential buildings in Germany. The height of the boxes indicates high or low impact.[x]



3.1 Information tools for building owners

Mass media

Mass media campaigns (e.g. CO2 Gebäudesanierungsprogramm campaign described by Weeber and others 2009) do not require active search by owners and hence can reach actors that have previously not been interested in pursuing energy efficiency investments. Mass media campaigns can include information about personal or environmental benefits of such investments. The impact of these campaigns are difficult to evaluate: most do not likely have direct effects, but contribute to long-term awareness and, if they work, stimulate an interest for further information (IEA 2005). In addition, results of a survey about retrofitting behaviour among 2000 German households by Novikova and others suggest that mass media campaigns can be important to move building owners from a "no plan" to a "planning" stage, but are less relevant for helping owners in their final decisions about energy efficient investments (2011).

Heating Bills

Heating bills reveal information about the negative implications of an inefficient dwelling by providing information on energy consumption and its financial cost. Bills can appeal to building owners that have previously not been interested into considering energy related investments, as well as to actors that are already considering an investment but need guidance on how they can achieve it. Survey results by Amecke suggest that energy bills are an important energy-related information source for helping purchasers make decisions on their dwelling choice (2011). Results from the US further suggests that their impact can be strongly increased by the use of detailed billing. Detailed billing can for example disclose information on the average consumption of similar households which triggers households to reconsider their energy use (Novikova and others 2011b). Currently only 7% of German households believe that they consume more energy than average (Friedrich and others 2007).

Energy Performance Certificates

Energy Performance Certificates (EPCs) are labels that reveal the energy performance of a dwelling and highlight potential retrofitting options. They are issued at the point of sale/rent of a building or after a major renovation. EPCs, like energy bills, are made available to actors regardless of the actors' interest in energy efficiency. Hence, EPCs can also encourage previously uninterested actors to consider investments in energy demand reductions of dwellings. As yet, however, EPCs do not appear to have a large impact according to most studies (Adjei and others 2011; Gram-Hanssen and others 2007; Lainé 2011; NHER 2009; Novikova and others 2011a). Hansen-Kjaerbye found, for instance, that EPCs do not trigger modernisations, while Amecke found that the impact of EPCs on purchasing decisions is currently limited, but is likely to increase with the update of the European Buildings Performance Directive (EPBD) that requires their mandatory presentation in building adverts (Amecke 2011; Hansen Kjaerbye 2008).

Internet

Internet tools provide various types of information that appeal to building owners at different stages of the decision-making process. These range from general awareness campaigns about the benefits of energy-related investments to tailor-made information about different retrofitting and support options for individual owners (e.g. co2online.de) (Novikova and others 2011a). Different studies have found that households perceive the Internet as one of the most relevant information sources for their retrofitting process (Novikova and others 2011b; Stieß and others 2010).

Desk Advice

Desk advice services, such as the German consumer associations' *Stationäre Energieberatung*, provide information to households about different energy demand reduction options, financial support options, and options to obtain further information. As actors need to actively contact the *Stationäre Energieberatung*, the programme appeals to actors that already have an interest in energy demand reducing investments. Yet, as it has a low cost threshold (a fee of 5 EUR for 30-45 min), the desk advice service also appeals to owners that have an interest but have not yet made plans for investments. The program's services are used by about 90,000 actors annually (including advice for electricity savings) and are estimated to trigger energy efficiency investments at a low cost, 6-12 EUR/tCO_2 (BMWi 2011; Duscha and others 2005).

Contractor Advice

Studies confirm that contractors are a major information source for retrofitting decisions (Krémer and others 2005; Novikova and others 2011b; Stieß and others 2010). As they are often on site for non-energy relevant modernisations, they can provide information both to uninterested building owners and to owners that are already considering several retrofitting options.

Energy Audits

Energy audits provide building owners with tailored information on the energy performance of their dwelling: an expert visits a dwelling, studies the current energy performance of a building, and provides information on retrofitting options, costs and benefits, and potential sources for finance. In Germany, there are various forms of energy audits, ranging from free advice from contractors under the programme *Haus Sanieren – Profitieren* (retrofit the house and profit) to comprehensive audits performed by an energy auditor supported by the BAFA programme, *Vor-Ort-Beratung* (onsite advice). The different audit types target different audiences: small scale, free or low-cost audits target owners with low interest in energy related investments, while large scale audits costing more than 300 EUR target actors that are certain that they want to conduct retrofits but are unsure which investments are cost-optimal (for a comprehensive description of different audit types view Dunkelberg and Stieß 2010). The "Haus Sanieren-Profitieren" programme is estimated to be conducted 79,000 times annually (produkt+markt 2010)[xi]. The BAFA energy advice was requested 20,000 times in 2010; CO_2 savings are estimated to come at a cost of 4.7 EUR/tCO_2, hence it represents a cost-effective policy (BAFA 2011; Duscha and others 2008).[xii] [xiii]

In addition to the above described energy audits, which are conducted prior to a retrofit investment, the *KfW programme 431* also requires the use of, and provides financial support for, energy audits during the retrofitting process (mandatory for retrofits to 45% less primary energy demand than new buildings, voluntary for other standards). This audit therefore aims to ensure an optimal implementation of the retrofit (KfW-Bankengruppe 2011b) and can also act as a training source for contractors for ambitious retrofit projects.

3.2 Information tools for contractors

Apprenticeship and Master Training Programs

There are several education and information programmes that support contractors in optimally implementing energy efficiency improvements and in providing advice to building owners. The German education system's three-year *Lehre* (apprenticeship), co-located at crafts enterprises and professional schools, provides foundational knowledge for contractors. The *Meister* (master) program provides further specialized training; a *Meister* degree qualifies a contractor to run a business and train staff within the specialisation.

Further Education and Other Tools

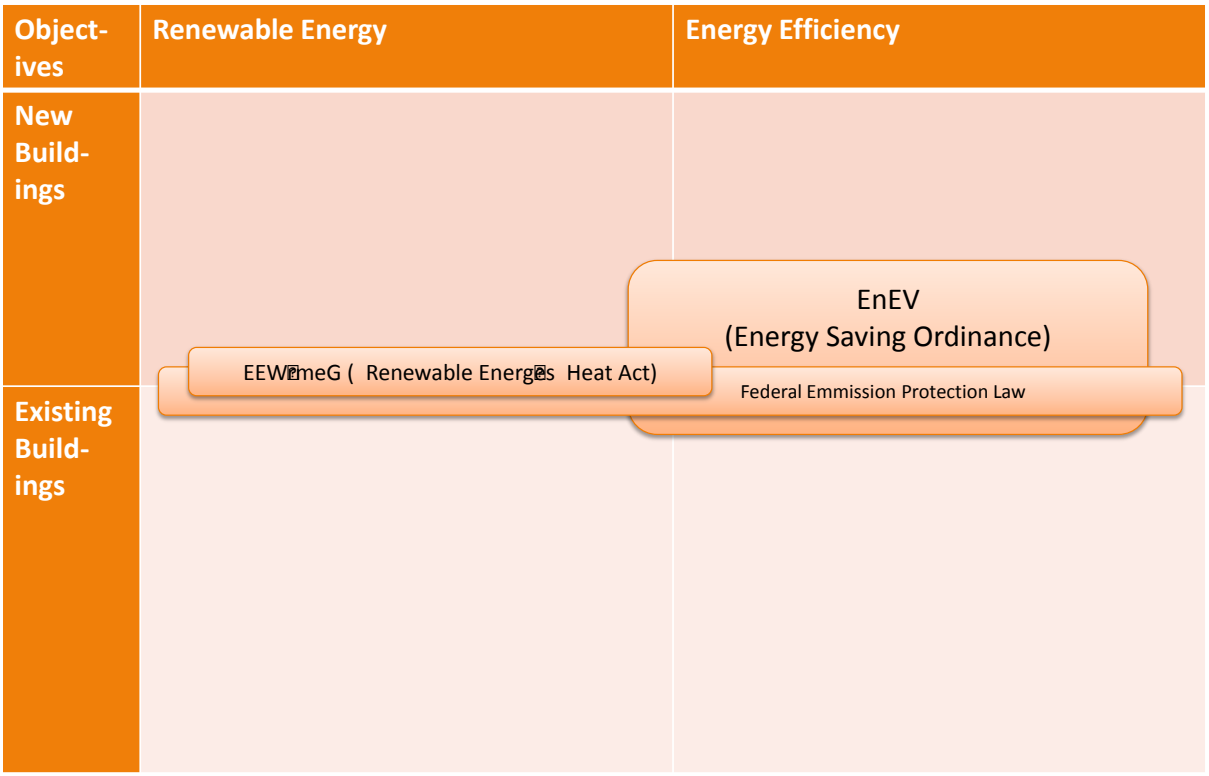
As building technologies and practices in general and energy efficiency technologies and practices in particular are constantly changing, contractors benefit from further education options provided by chambers of crafts (Handwerkskammern), guild associations (Innungsverbände), technology producers, and other organizations. In addition there are various further information sources targeting contractors, ranging from Internet tools (e.g. www.zukunft-haus.info) to guides and fairs.

Evaluations of the current state of education of contractors are conflicting, yet most authors indicate that energy efficient construction, retrofits, and communications skills currently occupy an insufficient share of the basic education of contractors which puts a higher burden on voluntary further education programs (Bühler and others 2007; Mohaupt and others 2011; Müller 2006). These programs are however not sufficiently demanded, among other reasons because most contractors companies are small and find it difficult to send all their staff to external education events (CPI Workshop Proceedings 2011; Mohaupt and others 2011).

4 Policies that legally enforce standards - The Sticks

The goal of standards is to provide minimum performance requirements for buildings and thereby address the remaining residential building owners who are not investing in energy demand reductions despite favourable economics, financial support, and information instruments. Two policy objectives can be distinguished: standards can either address the thermal energy efficiency of buildings or address the share of renewable heat supply.

Figure 3: Standards and their role in supporting energy demand reducing investments in residential buildings in Germany. The height of the boxes indicates a high or low impact of the policies.[xiv]



The following policies address these objectives in Germany:

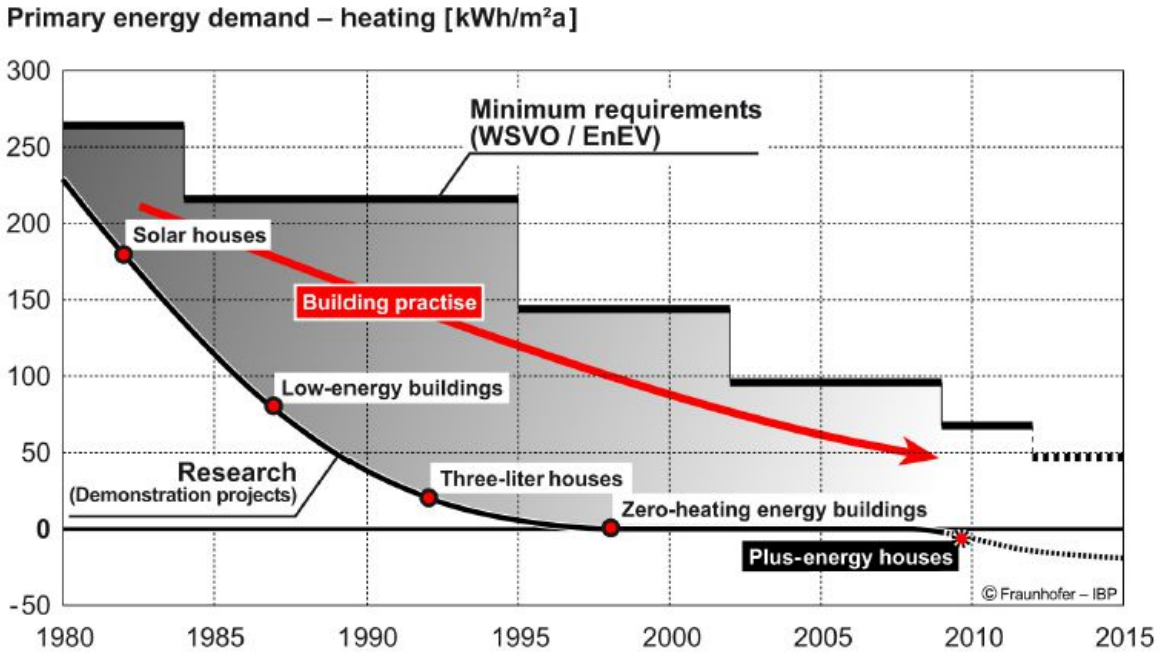
4.1 Energy Saving Policies

Energy Savings Ordinance (EnEV) – Requirements and compliance procedure
EnEV 2009 (*Energieeinsparverordnung* - Energy Savings Ordinance) is the main performance standard for new and existing residential and commercial buildings. The performance requirements differ for new and existing buildings. For the former, EnEV sets a standard for primary energy use, and allows the building owner to determine a combination of insulation, heating, and ventilation systems, and potentially integrated renewable energy to achieve this objective.[xv] The trade-off between renewable heat and energy efficiency is limited, as EnEV also sets a requirement for maximum transmission heat losses.

The primary energy requirements are not set at a fixed value, but differ for individual buildings. The reason is that the requirements of EnEV are calculated for a model building which demands less

stringent absolute requirements for buildings with a larger surface area. As a consequence, requirement for single-family houses are slightly lower than for multi-family houses.

Figure 4: Energy performance standard history in Germany. Source: Erhorn and Erhorn-Kluttig, 2009



For existing buildings, the ordinance only applies to changes of outer components, if at least 10% of the component surface is affected by the retrofit. Owners can decide whether they aim to fulfil the EnEV based on primary energy requirements of the whole building (which limits energy consumption to a maximum of 140% of new built requirements) or whether they only want to fulfil the requirements for the actually retrofitted components (§ 9). In addition to regulations which come into effect if a modernization is conducted, EnEV also has few minimum requirements for existing buildings in general. These include the replacement of boilers installed before 1978, or the insulation of heat distribution systems and warm water pipelines (§ 10). In general, EnEV requirements cannot impose requirements that are not economically viable for the investor (§25 EnEV).

For both new and existing buildings, the following compliance procedure applies: the main responsibility for compliance lies with the builder as well as any contracted party within the area of the latter's influence (§ 26 EnEV). *Länder* (German federal states) regulate the main aspects of compliance control (§§7, 7a EnEG) by transferring procedures to relevant authorities (Stock 2010), mainly to the *untere Bauaufsichtsbehörden* (lower construction control agencies). Due to this state-level implementation, compliance procedures differ because states can decide on the scope and depth of these procedures (Schmieskors 2010). We explore the compliance procedure in North Rhine Westphalia (NRW), Germany's most populous state:

- New buildings: § 2 EnEV UWO (NRW's ordinance for the implementation of EnEV) requires that the building plans are controlled by an independent certified expert (*Sachverständige Schall- und Wärmeschutz*). The expert certifies the compliance of a building with EnEV at the planning stage. Results are documented with an energy performance certificate,[xvi] and reported to the lower construction control agencies before the beginning of the construction process[xvii]. The compliance with the reporting requirement can be subject to spot checks. After completion of the building, construction companies need to submit a compliance statement to the construction control

agencies[xviii]. This reports insulation of outer parts, upper ceilings, and space and water heating systems, including distribution and cooling systems.

- Existing buildings: if a builder uses the option to achieve an energy performance of 140% of the standard of new buildings, then the same compliance procedures apply as for new buildings. If the builder selects the component-based option, a different compliance procedure applies. § 26a EnEV demands that construction companies need to issue a statement of compliance for the relevant components they have installed. These compliance statements do not need to be sent to the construction control agencies but only need to be stored and made available on request. The spot check controls by the certified experts do not apply to these existing buildings. The only established control is pursued by chimney sweeps, on the age of the boiler and existence of an insulation of the warm water systems, but not on other aspects like the building shell.

In summary, the design of the compliance procedure has the following advantages and disadvantages: i) issuance of compliance documents controlled or conducted by certified experts implies that builders and constructing parties have to comply with the regulation on paper and are subsequently liable; ii) spot check controls limit intentional and unintentional non-compliance. However, iii) spot check controls are not demanded by federal legislation and are implemented at discretion of the respective state; iv) for changes to existing buildings, the compliance procedures are less stringent, as documentation is only stored and not reported; v) spot check controls for existing buildings are limited to heating systems; and vi) changes to existing buildings often do not require a construction allowance, and are therefore not noticed by construction control agencies, preventing the control of certification and implementation process.

For the whole of Germany, non-compliance estimates for new buildings reach 25% or even 35% (Weiß and Vogelpohl 2010). Non-compliance is likely to be higher for existing buildings. Strengthening compliance has also been declared as a goal in the "Energiewende" (the German 2011 decisions on phasing out nuclear energy and increasing renewables and energy efficiency) (BMWi/BMU 2011).

4.2 Renewable Energy Policies

Renewable Energies Heat Act (EEWärmeG)
The *EEWärmeG* (*Erneuerbare Energien Wärme Gesetz* – Renewable Energies Heat Act) demands the minimum use of renewable heat production for new buildings. New buildings need to have at least 15% of heat production sourced through solar equipment, 30% through gaseous biomass, or 50% through other biomass installations, ambient heat, or geothermal heat. The requirements of EEWärmeG can also alternatively be fulfilled through a 15% over-compliance of EnEV or a 50% supply of heat by combined heat and power/waste heat or 100% supply by district heat[xix] . In principle, the EEWärmeG allows states to apply these regulations also to existing buildings, yet this has so far only been conducted by the state of Baden-Württemberg.

The EEWärmeG has a stricter control system than the EnEV as it requires states to pursue compliance spot checks (§ 11, EEWärmeG). However, no comprehensive *ex-post* impact evaluations of the EEWärmeG are known due to the recent implementation of the law. Ex ante calculations attribute medium CO_2 savings to the programme (Matthes and others 2009), yet qualitative reviews expect a low additional impact of the EEWärmeG because a) the new built rate is low (Augsten in Weiß & Vogelpohl 2010) and b) because the primary energy requirement in EnEV means that builders can in principle offset the installation of renewable energy with a decrease in the insulation of the thermal shell. As a result, EEWärmeG can be achieved just by fulfilling EnEV (Pehnt and others 2009; Rabenstein 2009).

Federal Emission Protection Law (BImSchV)
The *BImSchV* (*Bundesimmissionsschutzgesetz* – the first ordinance for the federal emission protection law) applies to small scale combustion plants. It includes provisions for the maximum emissions of dust and carbon monoxide as well as for minimum degrees of efficiency for new and existing combustion plants. The compliance is controlled by chimney sweeps. The impact of the BImschV on CO_2 emissions savings is estimated to be low (MURE 2006).

5 Conclusion

This paper has provided a short overview of the German policy landscape for increasing the thermal efficiency of the residential building sector and addressed two questions.

First, what roles do different policies play and how do they interact? We described three policy types addressing different needs of building owners. Financial instruments improve the economics of investments, information instruments provide information about these economics and further non-economic advantages of investments, and performance standards address those who do not respond to information and economic incentives. We emphasized that these policies can be complementary and that a cost-effective energy demand reduction requires a balanced policy mix in which each instrument effectively fulfils its role.

Second, which policies fulfil the different roles necessary to increase investments into thermal efficiency? How do these policies perform? We defined the role of different policies in supporting building owners in the decision process. Financial instruments were for example structured into instruments that a) provide low-cost capital, b) provide upfront support, c) change heating costs and, d) align incentives. Subsequently, we described the existing policies in Germany that address these roles and where available, shared current knowledge on their performance.

This policy framework is consecutively used as a foundation for detailed analysis of policy effectiveness in accompanying CPI reports and future work.

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Footnotes

[i] The paper only qualitatively distinguishes between two impact sizes, "high" and "low" due to the lack of ex post impact assessments for the majority of instruments. The impact is based on a literature review of existing studies and on expert judgment where no studies were available.
[ii] Preferential loans are loans with interest rates below the market price.
[iii] This excludes the 22,336 million EUR loan granted to the Greek government.
[iv] KfW also provides incentives for large renewable energy installations under the umbrella of the programme Erneuerbare Energien Standard (Renewable Energies Standard) and Erneuerbare Energien Premium (Renewable Energies Premium). These programs however go beyond the scope of this paper.
[v] For a more detailed description of the support provided by KfW view for example Neuhoff and others, 2011 b.
[vi] Besides energy related programmes, building owners can also apply for non-energy related programmes at less favourable conditions (e.g. *Wohnraum Modernisieren* – Modernise living space).
[vii] MAP also provides support of large-scale installations with an additional loan relief administered by KfW. This support for large scale installation is however not in the focus of this review.
[viii] Architects are equally important implementing agents, yet have not been covered by this paper.
[ix] For an overview of international best-practice information instruments view for example Novikova and others, 2011.
[x] The paper only qualitatively distinguishes between two impact sizes, "high" and "low" due to the lack of ex post impact assessments for the majority of instruments. The impact is based on a literature review of existing studies and on expert judgment where no studies were available.
[xi] This number is only based on a presentation by product+markt, yet the underlying study was not available.
[xii] In addition there are several energy audit programmes on the Länder level, such as Gebäude-Check Energie (building-check energy), which however are not covered by this study due to its focus on federal programmes.
[xiii] An ongoing CPI study therefore investigates how the uptake of energy audits can be increased (Amecke and others forthcoming)
[xiv] The paper only qualitatively distinguishes between two impact sizes, "high" and "low" due to the lack of ex post impact assessments for the majority of instruments. The impact is based on a literature review of existing studies and on expert judgment where no studies were available.
[xv] and lighting for commercial buildings
[xvi] In case that certification was already conducted by a third party, then certified experts only control the accuracy of these documents.
[xvii] However, § 68 (3) BauO NRW allows (among others) residential buildings of small height with one or two dwellings to follow a simplified application procedure which does not need the control of certified experts (Schmieskors 2010).
[xviii] This applies only to buildings that demand a building license (Schmieskors 2010).
[xix] of which a large extent is derived through renewable energies or at least 50% through waste heat or through CHPs.