Combining theoretical and empirical evidence: policy packages to make energy savings in buildings happen

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Abstract

What are the best policies and measures to stimulate energy efficiency in buildings? The debate around this is at least as diverse as the markets and concepts for energy efficiency in buildings, and often quite controversial. However, no magic formula seems to have been found so far. It is, therefore, time to address the question in a new way – by combining both theoretical evidence on what policy support markets need, and empirical evidence on which combinations or packages of policies have worked.

In the context of its new four-year project bigEE – "Bridging the Information Gap on Energy Efficiency in Buildings", the Wuppertal Institute is implementing this new approach. The bigEE project aims at developing an international internet-based knowledge platform for energy efficiency in buildings. Hence, it must provide evidence-based information. On the theoretical side, the analysis starts with value chains in the building sector and the barriers but also actor-inherent incentives that the different types of market participants face. This enables to identify, which policies and measures need to be combined to jointly overcome the barriers and strengthen the incentives. On the empirical side, model examples of good practice are collected and compared. The search for these is guided by the results of the theoretical analysis, international expert opinion, and existing databases and platforms. In order to identify what is 'good practice', the project uses a newly developed multi-criteria assessment scheme. Finally, the impacts achieved with the model examples, lessons learned, and their transferability will be used to validate the model policy package identified in the theoretical analysis.

The public launch of the bigEE platform is planned for autumn of 2011; eceee Summer Study participants will get a first glance at its content through this paper. The paper presents the methods and tools used and showcases their application for the case of new buildings.

Introduction

Buildings are frequently identified as one of the major sources of energy use and are therefore a – if not *the* – crucial area to target when it comes to seriously cutting greenhouse gas emissions. This is all the more obvious in light of the huge energy saving potential that springs from the abundance of options for cost-effectively improving the energy performance of buildings. The extraordinarily long lifetime of buildings makes this point even more valid as the energy savings achieved through better building performance will persist for a long time.

In particular, the soaring rates of new construction in industrialising economies such as China and India urgently call for a radical change in the way we design and build new properties. Action needs to be taken now in order to avoid major lock-in effects. We have to abandon the prevailing 'as-fast-and-cheap-as-possible' construction approach because it systematically ignores lifecycle costs and creates buildings that will be wasting enormous amounts of energy and money throughout their whole lifetime.

What is required instead is a u-turn in construction practice towards more sustainable, integrated design concepts that make ultra-low- or even zero-energy buildings possible. Such buildings already exist in many countries (Global Energy Assessment, 2011), and the technologies and the design know-how that are necessary to cost-effectively build them are available; however, the challenge remains to transform the building sector in a way that such ultra-low energy buildings will no longer be an exception but become the standard choice of market actors. The challenge is even bigger for existing buildings, an area which is far more important than new-build in OECD countries.

Numerous studies are confirming that enormous energy saving potentials can be realised by improving building energy efficiency, and also that most of the available improvement options are cost-effective from a life-cycle perspective as long as they are done in new built or in line with normal reinvestment cycles. Yet, at least as many papers have concluded that inspite of their cost-effectiveness these savings are not going to be realised by market forces alone. This lack of market uptake results from a large variety of barriers and market failures. These are especially powerful and persistent in the case of buildings because of the complexity of the sector and the multitude of actors involved. And even though the history of policies and measures aimed at improving building energy performance is as extensive as the debate around them has been long and contentious, no optimal way to deal with these barriers has been found yet.

Within the new bigEE – "Bridging the Information Gap on Energy Efficiency in Buildings" – project, we therefore tried to address in a different way the question of how improved building energy efficiency can be supported most effectively – by combining a theoretical, actor-centred analysis with empirical evidence on model examples of good practice. The bigEE project started from the finding that information on energy efficiency technologies and policies is, albeit abundant, very scattered and decision makers find it difficult to access. The project seeks to address this problem by summarising knowledge and presenting comprehensive, independent and high-quality information on energy efficiency in buildings on its international website. In particular, the project aims to make the information about existing policies and buildings / technologies throughout the world comparable and present it in a targeted way so as to support investors and policy makers in making the right – energy-efficient – choices.

While the bigEE web portal will include information on both new and existing buildings as well as appliances, for the purpose of this paper we limit the analysis to the case of new buildings. By closely analysing value chains and incentive structures in the building sector and then deducing implementation strategies and ultimately packages of policies from the findings, this paper aims to provide a solid methodological basis for the often-quoted necessity to implement comprehensive policy packages. Consequently, our focus here is rather on presenting the methodology we used for identifying the ideal policy package - and its exemplary application in the case of new buildings - than the outcome, i.e. the optimal package itself. The methodological approach we use is based on and seeking to extend and refine the theory-based policy evaluation approach which goes back to US experiences with energy efficiency policy evaluation (e.g., Blumstein et al. 2000) and was applied and developed further more recently within the EU project AID-EE[1] (cf. Ecofys et al. 2006).

The remainder of this paper is organised as follows: first we describe the actor-centred approach, which starts from the analysis of barriers and actor-inherent incentives, then develops strategies to address these barriers and incentives, and finally determines which combinations of policies and measures are needed to make these strategies work. We then compare the outcome of this analysis, i.e. the theoretically ideal policy package, with empirical evidence on combinations of policies and measures that have actually worked and delivered significant energy savings. In this context we also outline the newly developed multi-criteria assessment approach we use for identifying good practice. Due to space constraints, we can only present small exemplary parts of the tables that we created for the analysis. The full versions can be found as a preview at www.bigee.net, which will be officially launched in autumn of 2011.

Theoretical analysis – the actor-centred approach

New construction of a building is a complex process consisting of different phases, namely design, financing, construction, installation of systems, commissioning (in case of commercial and large residential buildings) and operation/use. This process also involves a significant number of different market actors, the most relevant of which are architects, developers, financiers, builders, contractors, component/material suppliers, and finally building owners and possibly tenants. Throughout the different phases of planning and construction, all of these actors make decisions that can influence the energy performance of the new building in question. And they all have some inherent incentives to develop, offer, demand or invest in energy-efficient building solutions, but are on the other hand facing strong barriers that prevent them from choosing energy efficiency.

In order to be able to adequately design and implement energy efficiency policies and measures, political decision-makers must therefore have good knowledge of the concerned market actors and thoroughly analyse the specific incentives and barriers faced by each of them. The compilation of an ideal policy package should be based on the

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[1] www.aid-ee.org

findings of such analysis insofar as the package should target all relevant actors and establish mechanisms to overcome the actor-specific barriers.

Analysis of actors and barriers

The complexities of the building sector require that all members of the value chain act in the right direction, or else the energy efficiency chain will break. It is therefore not sufficient to merely look into the factors that induce or prevent uptake of energy efficiency measures at the level of end-users (i.e. the incentive structures of building owners and tenants). Consequently, we seek to identify and closely examine the barriers and incentives of *all* relevant actors in the value chain. This enables us to understand more thoroughly why they often do not implement energy efficiency; and as a next step it makes it possible to develop appropriate remedies in the form of tailored policy packages which aim to remove the barriers and strengthen the incentives identified.

In the building sector, the most important barriers that have so far prevented a large-scale market transformation include lack of knowledge and awareness of energy saving options, uncertainty about the related monetary and other benefits, capital constraints and risk aversion, lack of motivation due to other priorities, transaction costs and the small size[2] of achievable energy savings, and finally the so-called landlord-tenant or investor-user dilemma (cf., e.g. Sorrell et al. 2004). The latter refers to the fact that in the case of buildings the actor bearing the costs of an energy efficiency improvement is often different from the one yielding the benefits (e.g., the landlord has to pay for the new heating system but only the tenant's energy bills are reduced).

Below we present an extract of the actor-specific barriers and incentives which we identified across the complete value chain (based on the analysis in Thomas 2007 and available literature). The relevance of some of these barriers and incentives may differ from country to country depending on national circumstances.

Table 1: Actors vs. actor-specific barriers and incentives (extract)

Actors	Actor-specific incentives	Actor-specific barriers
…	…	…
Property development companies	➢ Justification for charging higher rents (rent premium) ➢ Increase occupancy rates ➢ Increase (re-sale) value of the property ➢ Contribute to environmental protection ➢ Receive social recognition in return for environmentally-sound behaviour	➢ Lack of knowledge about the market demand for energy-efficient buildings: will customers be willing to pay a rent/ sales price premium for a more energy-efficient building? ➢ Extra construction cost: risk of losing customers to the competition (assuming that customers look at first cost only) ➢ Investing in energy-efficient technologies is more expensive compared to conventional technologies → reduces my profits ➢ No direct economic benefit from reduced energy bills: only tenants will save energy costs!
…	…	…
Investor-occupier (building owner)	➢ Save energy costs ➢ Increase (re-sale) value of the property ➢ Contribute to environmental protection ➢ Receive social recognition in return for environmentally-sound behaviour ➢ Present ourselves as innovative and gain competitive advantage	➢ Uncertainty about costs and benefits: How much will it cost me? How much can I save? ➢ Uncertainty about ability to reap the benefits: will I still live in this building 5 years from now (assuming a payback time of more than 5 years)? ➢ Lack of knowledge about options for making the building more energy-efficient; is it worth the effort informing myself? ➢ Transaction costs of obtaining information as to: Which are the adequate solutions for my building? Which architect/ contractor/ supplier offers the best value for money? Etc. ➢ Excessive expectations in terms of payback (due to capital restrictions, uncertainty) ➢ Reluctance/scepticism towards new products/ technologies: will they offer the same quality, functionality, and safety? (risk aversion) …

[2] While for the individual house-owner or tenant the possible savings may appear small, they can contribute substantially to achieving the climate and energy policy goals mentioned above when they are aggregated over all end-users.

Implementation strategies needed to overcome the identified barriers

Once we have identified the reasons that cause actors to be inclined towards or to refrain from choosing low-energy buildings, the question to be solved remains: How can the immanent incentives that market actors have be strengthened, how can the barriers they face be overcome? There are a number of direct ways to achieve this, which we call implementation strategies. By way of addressing the actor-specific incentives and barriers, these strategies aim to make energy efficiency feasible, easy, and attractive, and eventually even the default. The following table, again showing only a small extract of our analysis, illustrates how the implementation strategies seek to influence each of the incentives and barriers identified.

Table 2: Implementation strategies vs. barriers / incentives (extract)

Implementation strategy	**Incentive strengthened or barrier tackled**
Ensure architects, property development companies, construction companies, and contractors that there is a market	(Architects, property development companies, construction companies, and contractors) Present ourselves as innovative and gain competitive advantage and social recognition (Architects) Need to change proven designs and constructions: will there be a market worth the effort? (Component manufacturers) Increase our revenue and profits by offering more expensive energy-efficient products (Component manufacturers) Risk of production and marketing: will there be sufficient demand so that the production change-over pays off, a minimum unit quantity is reached, and the price can be kept on a competitive level? (Component manufacturers, manufacturers of pre-fabricated houses) Risk of technical development: will there be a market for energy-efficient buildings or products? Will we be able to recover the development costs? (Property development companies) Lack of knowledge about the market demand for energy-efficient buildings: will customers be willing to pay a premium? (Property development companies, manufacturers of pre-fabricated houses, component manufacturers) Prevailing price competition or predominance of other product features over energy efficiency; therefore low priority/willingness to pay (more) for energy-efficient buildings
Inform investors of the energy-efficient building types, available energy saving options (technological, organisational and behavioural), their benefits and net savings to be made, using results of demonstration projects	(Investors) Uncertainty about associated benefits and costs: How much can I save? How much does it cost me? Is it worth to inform myself? (Investors) Lack of knowledge about (technical) options for making the building more energy-efficient (Investors) Transaction costs of obtaining information (Architects, construction companies) Extra construction cost: risk of losing customers to the competition (assuming that customers look at first cost only)
Fund demonstration projects and train architects, construction companies, and contractors about their technologies, solutions, and net savings	(Architects, construction companies, contractors) Present ourselves as innovative and gain competitive advantage (Architects, construction companies) Will the energy-efficient house standard be achieved (risk of customer dissatisfaction)? (Architects, construction companies, contractors, investors) Lack of knowledge about (technical) options for making the building more energy-efficient: Is it worth the effort informing myself? (Investors) Uncertainty about associated benefits and costs: How much can I save? (Investors) Scepticism towards new products/ technologies: will they offer the same quality, functionality, and safety? (Investors) Lack of motivation: demonstration projects and particularly trained supply chain actors are more likely to convince investors of the benefits of energy-efficient buildings
…	…

Policy packages to realise the implementation strategies

As a next step, political decision makers but also non-governmental actors such as, for instance, energy service companies must take concrete measures and enact actual policies in order to put the implementation strategies to work. For each of the implementation strategies, a package of policies and measures is needed to make it work, and since also a combination of implementation strategies is necessary to tackle the manifold barriers, these targeted policy packages must then be merged into a consolidated overall package which is ultimately capable of kickstarting a real market transformation in the building sector. This “ideal policy package” will be presented in the next section.

For the exemplary implementation strategies presented in table 2, the corresponding policy packages can be found in the following table.

Table 3: Implementation strategies vs. policy packages (extract)

Implementation strategy	Policy Package
Ensure architects, property development companies, construction companies, and contractors that there is a market	Information and advice programmes both for building investors and for architects, construction companies, and contractors Financial incentives for very energy-efficient new buildings (in order to increase the demand) Social housing investment (to provide a first visible demand) Dynamic building codes: Step 1 remove conventional practice from the market; step 2 announce future tightened levels to create expectation of future market for energy-efficient designs Mandatory (initially maybe also voluntary) building energy performance or green building certificates to enable and prove differentiation Long-term strategies/ political commitments: e.g. Zero Net Energy targets and roadmap
Inform investors of the energy-efficient building types, available energy saving options (technological, organisational and behavioural), their benefits and net savings to be made, using results of demonstration projects	Information and advice programmes and centres, information campaigns Professional training programmes Financial incentives for very energy-efficient new buildings Mandatory Energy Performance Certificates or other building energy labelling schemes (to reach full impact, these measures should ideally be combined with implementation support: advice and financial incentives/ financing) Demonstration activities/ projects ‘Lead-by-example’ programmes in the public sector Calculation tools for assessing costs and benefits over lifecycle taking risk and uncertainty into account (e.g. sensitivity analysis) Require use of such LCC calculations on at least two design options
Fund demonstration projects and train architects, construction companies, and contractors about their technologies, solutions, and net savings	Financial incentives for demonstration projects Professional training programmes ‘Lead-by-example’ programmes in the public sector
…	…

The ideal policy package resulting from the theoretical analysis

If we want to afford heating, cooling and lighting our buildings in 10 or 20 years from now and prevent runaway climate change, we need to achieve that operational goal: make ultra-low-energy buildings (ULEB) the standard in new construction. What can policy do to support making that happen?

Resulting from the theoretical analysis, we can derive the elements that should ideally be included in a comprehensive policy package to achieve that goal. We can only give here an overview of these elements:

- A Policy Roadmap towards ultra-low-energy buildings should guide policy-making, with a clear timetable and targets towards ULEB.
- The infrastructure and funding for the other policy elements need to be in place (i.e., an energy agency or similar and government funds, and or energy companies with the task to implement incentive programmes).
- Energy prices should ‘tell the economic and ecological truth’. Energy production and price subsidies should be gradually removed (the budget saved should rather be used to fund energy efficiency schemes for low-income households, so as to keep their energy *bills* affordable instead of energy *prices* artificially low), and energy or CO_2 taxes should finally internalise environmental damage into final energy prices.
- Minimum energy performance standards (MEPS) for all new buildings (and building components where useful) should be created by law (in a transition period before a law can be passed, a voluntary standard may help). MEPS reduce transaction costs as well as the landlord-tenant and developer-buyer dilemmata by removing the

least energy-efficient building practices and concepts from the market. They should, however, always be at least as stringent as the level of least life-cycle costs. Landlord and tenant laws may need to be revised, too, in order to make energy efficiency more attractive for both sides.

- A step in MEPS regulation should be prepared by education and training of architects, planners, developers, builders, contractors, lenders and other market actors, but education and training should also include the next steps up to ULEB. Easy-to-use design and life-cycle cost calculation tools are essential. Certification of training can make it more attractive for both the qualified market actors and their customers.
- The next step(s) to ULEB should, furthermore, be prepared by a building energy certificate scheme (and energy labels for components if useful), marketing of demonstrated good practice, advice and support for investors, and financial incentives for broad market introduction. Promotion of energy services for energy savings and voluntary agreements with large developers to build more energy-efficiently than required by MEPS may also support market introduction. Once a certain market share of (ultra) low-energy buildings of a specific energy performance level is reached, the professionals are trained and used to the required practices, and the cost-effectiveness of the next step is proven, then this next step can be mandated by the regulation.
- The steps after the next step should be prepared by R&D funding, demonstration (including in state- or municipality-owned buildings), award competitions, and maybe also already by financial incentives for broad market introduction.

Empirical analysis of good practice examples

As a next step we then wanted to find out whether the results of our theoretical analysis are consistent with actually implemented examples of successfully operating policy packages. Consequently, we had to search for empirical evidence of good practice.

How to select good practice examples

Even though ‚good practice’ is a heavily used term in policy analysis and evaluation, it nevertheless remains rather vague. This is why we felt the need to find a new and more exact definition for it in the course of the bigEE project.

For this purpose, we have developed a set of selection criteria which can be used to determine whether or not a certain policy qualifies as ‚good practice’. These criteria range for instance from appropriateness of the policy design to availability of ex-post evaluation to questions of effectiveness. They are then weighted according to their relevance as can be seen in the table below, which also presents the full range of criteria applied. This procedure results in an overall score, which then indicates whether the policy actually is considered good practice or not.

Taking account of the fact that there may be policies that will not be able to fulfil certain criteria (mostly those addressing quantitative impacts) simply because they are too recent, we differentiate between so-called proven and innovative policies and measures. In this context, we apply a slightly different assessment scheme to the innovative ones, with less focus on achieved results and instead putting more weight on promising design elements that seek to make policy more effective, for instance by targetting actors and/or barriers so far neglected.

Table 4: Selection criteria for good practice of policies and measures

Selection Criteria Good Practice P&M		**Operationalisation**	**Weight for selection**		**Comments**
			Proven P&M	**Innovative P&M**	
The policy has been **successfully** and durably **implemented** into the market		Implemented	Eligibility	Eligibility	P&M is in force at least in one country
		At least 2 years in place	Eligibility	n/a	At least in one country
Recent P&M		Not older than 10 years before date of website publication	If not, justification required	If not, justification required	Last revision date of the P&M counts
Appro-priate design of P&M	Addresses **all relevant market actors** and **most relevant barriers and incentives**	Ranking as a whole on a scale between 0 and 10	30%	40%	Often better achieved when policy is part of a package
	Is designed to **avoid lost opportunities**				For example, addresses the energy-efficient solutions in the right manner and moment, e.g., by taking into account the investment cycle of the

					target group
	Aims at **dynamic** market transformation				For example, promotes innovations to make BAT even more energy-efficient, and/or, increasingly removes inefficient technology/practices from market
	Achieves **lasting results**				For example, no snap-back effect
	Positive **spill-over** effects should be an objective				Large multiplier effects
Includes **innovative P&M elements** or combines them into an innovative P&M package		Ranking on a scale between 0 and 10	10%	30%	Outstanding compared to other countries, e.g.: market actor addressed who is not included in other existing P&M; an innovative way to overcome barriers; innovative package of P&M
Does the P&M foster **worldwide BAT** or country-specific **LLCC solutions**?		Close to BAT/LLCC = 10; Substantially different from BAT/LLCC = 0	10%	15%	Dynamic life-cycle cost analysis including typical interest rates
A satisfying **ex-post evaluation** exists		Yes = 10; no = 0	10%	n/a ex-ante data if possible	Ex-post evaluation usually gives more reliable data than ex-ante evaluation
The energy savings are **cost-effective** (for consumers and the economy)		Benefit-cost ratios from different perspectives	If no data or not cost-effecti-ve, justification required	n/a ex-ante data if possible	Dynamic life-cycle cost analysis including correction factors and typical interest rates
Effectiveness I: The P&M leads to **energy savings per unit** (per appliance, per building) compared to reference case		Is data on energy savings per unit available? Please give absolute and relative numbers.	Not eligible, if no data	n/a ex-ante data if possible	Expected additional, yearly energy savings in %/yr and in kWh/yr per unit (per appliance, per m2 or per building) compared to baseline projections
Effectiveness II: The **effectiveness** is high: How many % of the energy savings potential available within a specific time frame due to normal investment/ refurbishment cycles in the target area (**region/country**) have been implemented?		Please give absolute and relative numbers (BAT or LLCC vs. reference; including correction factors), and then rank on a scale between 0 and 10.	30%	n/a ex-ante data if possible	E.g., at least 30% of the potential has been implemented; or the share of energy-efficient technology has increased considerably; or the price premium on energy-efficient technology has decreased; or a service has saved on average at least 30% of the customers' energy consumption
The policy is in line with other **sustainability** criteria		Ranking on a scale between 0 and 10	10%	15%	Other aspects like material efficiency, health or employment aspects taken into account
Mix of countries / continents		Final selection of portfolio	Global perspective, mix of countries		

Abbreviations: P&M – Policies and measures; BAT – Best available technology; LLCC – Least lifecycle costs

Model examples of good practice: proving the actor-centred approach right

As the most advanced countries show, the policy package that we derived from our actor-centred analysis is exactly what these countries have introduced to approach very high levels of energy efficiency in new buildings. As an example, we discuss Upper Austria's sustainable building programme for residential buildings.

Upper Austria's sustainable building programme

Since 1993, the regional energy agency (O.Ö. Energiesparverband) has been implementing a multi-pillar strategy to transform the building sector and create an energy efficiency market in Upper Austria, the fourth largest Austrian federal state. The strategy focusses on actors and aims to change mind-sets, behaviour and investment strategies. In order to achieve this goal, it combines legal requirements with attractive financial incentives, professional training and information & advice measures.

Coherent sectoral policy packages have been established to specifically target residential, public and commercial buildings respectively. Key measures for the residential sector include:

- an overall energy saving target of 1% (1.5% for the public sector)
- minimum energy performance standards
- energy performance rating & certificates
- financial incentives (soft loans) dependent on the energy performance rating results (the requirements are tightened by about 5% every year)
- mandatory on-site energy advice for programme participants (prerequisite for getting the financial support)
- courses & training programmes for energy consultants and other building professionals
- information, advice and financial incentives targeting installed systems (e.g., replacement of inefficient circulators, installation of condensing boilers)
- RD&D support (technology programme „Building of Tomorrow – Haus der Zukunft")
- network of green energy businesses
- events, campaigns and competitions

In the period 1993 – 2007, more than 74,000 buildings (new and refurbished) met the requirements, which led to energy savings of 350 million kWh/year. An evaluation showed that the implemented measures were very cost-effective, with every kWh saved costing only 1.8 Eurocent. Furthermore, several hundred passive houses have been built due to the programme in recent years (Egger/Öhlinger 2009).

Discussion and conclusions

The actor-centred approach has confirmed our presumption that there is not one silver bullet that will kick-start a real transformation in the building sector. What is urgently needed instead are consistent packages of policies and measures, carefully tailored to the needs and incentive structures of all actors in the building value chain. Our theoretical analysis along this value chain has given us good insight as to which implementation strategies can successfully tackle the many existing barriers and which combinations of policies are needed to put these strategies into practice.

We also ascertained that the main elements of the theoretically ideal policy package can indeed be found in real life in the policy packages of advanced countries. In addition, we have conceived a set of criteria that makes it possible to identify policies and packages of policies that are likely to be very effective and therefore qualify as good practice according to our criteria.

During our research on such model examples, we found, however, that the lack of thoroughly documented and evaluated policies and measures makes the search for good practice and the application of our multi-criteria assessment scheme quite difficult. Accordingly, resulting from our analysis there are two key messages for policy makers planning to implement a new policy or measure: it is crucial already in the policy design phase to bear in mind both the actors concerned *and* the data needs and other requirements in terms of monitoring and evaluation.

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