Policy Guide

Assist markets in becoming energy-efficient

bigEE

The recommended package for buildings: what actors need and which policies advanced countries combine

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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; the reader will get a first glance at its content through this paper. The paper presents the methods and tools used in the combined analysis and showcases their application for the case of new buildings.

1. 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

[1] www.aid-ee.org

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.

2. 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, sale/letting, 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 tenants/users. 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 findings of such analysis insofar as the package should target all relevant actors and establish mechanisms to overcome the actor-specific barriers.

2.1. 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 general 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 dif-

[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.

ferent 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).

Based on this more general categorisation of barriers, the following table presents the actor-specific barriers but also incentives which we identified across the complete value chain (based on the analysis in Thomas 2007 and available literature). The actor-specific incentives are market-inherent drivers for higher energy efficiency, but usually they are too weak to counterbalance the barriers. The relevance of some of these barriers and incentives may differ from country to country depending on national circumstances.

Actors	Incentives	Barriers
Component manufacturers (construction materials)	The actors on the supply side of the building sector share the following market-inherent incentives for offering, developing or choosing energy-efficient solutions: The energy-efficient option usually requires higher up-front investment: from a supply perspective, this means higher revenues and possibly higher profits (if customers are willing to pay more due to the expected energy cost savings). Note: this point is only valid for active options, since implementing passive options (except for insulation and controls) will decrease revenues instead Offering energy-efficient solutions can act as a unique selling proposition and thus lead to competitive advantages or even market leadership Both end-users and the environment benefit from energy-efficient solutions: offering such solutions thus underpins a company's CSR goals (reputational benefits) Offering higher value to the customer (but there are other options for that)	Prevailing price competition or predominance of other product features over energy efficiency; therefore low priority and low willingness or ability of customers to pay (more) for energy-efficient products; Risk not to be able to produce more energy-efficient materials/ systems in the same cost range. Market risk of technical development: will there be a market for energy-efficient buildings and products? Will we be able to recover the development costs? Quality risk of technical development: Will the energy-efficient product offer the same functionality, reliability and safety as the conventional one so that our customers and the users won't be dissatisfied or burdened? 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? Lack of knowledge about technical options for making the product more energy-efficient Uncertainty about availability of sufficient quantities of reasonably priced components
Component manufacturers (installed systems)		
Construction companies		Liability for safety and functionality of the building / installed systems: Will the energy-efficient building offer the same technical functionality and safety as the conventional one so that we won't have to face liability issues and that our customers won't be dissatisfied? Lack of knowledge about technical options for making the building more energy-efficient; is it worth the effort informing myself? Power of habit and good experiences with certain suppliers: if the energy-efficient components/ materials are only being offered by a new supplier there is uncertainty about his reliability and about the products' quality; is it worth the effort informing myself about new suppliers? In some cases a change of supplier may
Other contractors (e.g., for windows, heating and cooling systems)		
General management companies		

		even be impossible because of existing contracts Increased revenue and profit can be attained if we sell larger and more expensive technologies/ installed systems; this can be both an incentive to sell energy-efficient systems (as they are more expensive) – this however only works if there is a demand for them – but also a barrier to more energy-efficient buildings: companies are usually inclined to offer larger systems which cost more and consume more energy Lack of knowledge about the market demand for energy-efficient installations: customers may not be willing to pay a (significant) premium for more efficient systems; Is it worth the effort convincing customers to spend more in return for a more efficient solution? Extra construction cost: risk of losing customers to the competition (assuming that customers look at first cost only) Will the energy-efficient building standard be achieved (risk of customer dissatisfaction)?
Architects / civil engineers		The official scale of fees for services by architects and civil engineers usually determines fees as a percentage of building construction costs: therefore they have incentives to plan the building with more/ larger installed systems than necessary; such fee structures also provide a strong barrier against integrated design and the implementation of passive measures since this requires a higher planning effort and at the same time reduces investment costs because installed systems will most likely be much smaller (or obsolete) due to reduced heating/cooling loads Liability for safety and functionality of the building/ installed systems: Will the energy-efficient building offer the same technical functionality and safety as the conventional one so that we won't have to face liability issues and that our customers won't be dissatisfied? Lack of knowledge about technical options for making the building more energy-efficient; is it worth the effort informing myself? Power of habit and good experiences with certain suppliers: if the energy-efficient components/ materials are only being offered by a new supplier there is uncertainty about his reliability and about the products' quality; is it worth the effort informing myself about new suppliers? In some cases a change of supplier may even be impossible because of existing contracts Will the energy-efficient house standard be achieved (risk of customer dissatisfaction)?

Consultants for energy, structure, M&E (mechanical and electrical design)	Consultants for energy can earn more, if fees for services are not dependent on the investment but on the amount of energy saved	Same barriers as for architects and civil engineers Except maybe for energy consultant: if fees for services are not dependent on the investment but on the amount of energy saved (then it is an incentive)
Property development companies	Justification for charging higher sales price or rents (price or 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 apartment/ building? Is it worth the effort convincing customers to spend more in return for a more efficient solution? Extra construction cost: risk of losing customers to the competition (assuming that customers look at first cost only) Prevailing price competition or predominance of other product features over energy efficiency; therefore low priority and low willingness or ability of customers to pay (more) for energy-efficient houses Developer-buyer dilemma: Investing in energy-efficient technologies is more expensive compared to conventional technologies → reduces my profits; at the same time no direct economic benefit from reduced energy bills: only tenants will save energy costs!
Manufacturers of pre-fabricated houses		Lack of knowledge about the market demand for energy-efficient buildings: customers may not be willing or able to pay a (significant) premium for more efficient buildings; Is it worth the effort convincing customers to spend more in return for a more efficient solution? Lack of knowledge about technical options for making the building more energy-efficient; is it worth the effort informing myself? Prevailing price competition or predominance of other product features over energy efficiency; therefore low priority and low willingness or ability to pay (more) for energy-efficient houses Risk of technical development: will there be a market for energy-efficient houses? Will we be able to recover the development costs? Will the energy-efficient product offer the same functionality, reliability and safety as the conventional one so that our customers and the users won't be dissatisfied?
Building Permission Authority		Incentive to limit their effort to control compliance with building regulations (including on energy efficiency)
Real Estate	Since the commission that	It is difficult to 'sell' energy efficiency features because

Agents	real estate agents receive is usually calculated as a percentage of the sales price or a multiple of the base rent, higher sales prices and rents caused by energy efficiency investments can increase the agents' income.	energy consumption is not visible; real estate agents might therefore fear not being able to find buyers/tenants for energy efficient properties (or at least they will have to put in higher effort to market them) when there are otherwise identical (size, age, quality) but cheaper buildings on the market.
Capital providers (banks, equity funders, etc.)	The default risk may be lower for credits used for energy efficiency projects than for other kinds of projects, since energy efficiency investments usually reduce the borrowers' monthly housing/ operating costs.	Uncertainty about how the investment will perform in terms of revenue and risk Lack of technical expertise and experience with this kind of projects (no performance track records available) Individual projects are too small to be interesting investments for equity funders; transaction costs of assessing risk and revenue for every single project are high The illiquidity and irreversibility of (most) energy efficiency investments increase the riskiness (IEA 2007, p.23). Not all benefits induced by energy efficiency improvement (e.g. reduced environmental costs, comfort increases, health improvement due to better indoor climate, etc.) are taken into account in traditional financial indicators (IEA 2007, p.23).
Investor-occupier	Save energy costs Increase (re-sale) value of the property Improve living conditions / comfort Contribute to environmental protection Live more sustainably Receive social recognition in return for environmentally-sound behaviour	Uncertainty about future energy prices: they may be low or volatile – 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)? Present-biased preferences: actors tend to value immediate payoffs disproportionately higher than future revenues; this is a strong barrier for energy efficiency investments as they often involve high up-front costs and lengthy payback periods; the uncertainties mentioned above add to this problem Lack of motivation because savings are too small, uncertainty about level of benefits and costs (Is it worth informing myself?), other priorities, etc. Lack of knowledge about options for making the building more energy-efficient; is it worth the effort informing myself? Lack of skills/knowledge required to assess lifecycle costs of a building (therefore only able to compare different options, e.g. conventional vs. ultra-low energy building, based on first cost) Transaction costs of obtaining information as to:

		Which are the adequate and most cost-effective solutions for my building? Which architect/ contractor/ supplier offers the best value for money? What do I have to consider in terms of tendering, final inspection, etc.? Lack of (access to) capital and / or other investment priorities Excessive expectations in terms of payback (as a result of capital restrictions, uncertainty about future developments, and other investment priorities) Reluctance/ scepticism towards new products/ technologies from new suppliers/ companies: will they offer the same quality, functionality, and safety? (risk aversion) Lack of energy management (mainly relevant for non-residential sectors but also for large investor-landlords/landladies and public building companies): as a result companies have insufficient knowledge about (the drivers of) their own energy consumption, fail to implement useful organisational energy saving measures, and face high search and transaction costs when they plan to improve their energy efficiency Misleading price signals due to rate design (standing charges, declining block rates) and lack of internalisation of external costs or even subsidised energy prices: the individual energy cost saving is thus lower than it would be if the total cost of energy supply were considered
Landlord/landlady/ Investor-landlord/landlady	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	Landlord-tenant dilemma: Investing in energy-efficient technologies is more expensive compared to conventional technologies → reduces my profits; at the same time, no direct economic benefit from reduced energy bills: only tenants will save energy costs! 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 apartment/ building? Plus all of the barriers listed under investor-occupier
Tenant	Save energy costs Contribute to environmental protection Receive social recognition in return for environmentally-sound behaviour	Landlord-tenant dilemma: Often not able to invest in thermal insulation, central heating or cooling systems etc. (only landlord can) Risk (or suspicion) that energy cost savings may be lower than increase in basic rent may lead to opposition from tenants to energy efficiency improvement actions by landlord/landlady Risk (or suspicion) that new EE technologies do not offer the same quality, usability, caring and living func-

		tionality and social, caring and usability safety may lead to opposition from tenants to energy efficiency improvement actions by landlord/landlady Lack of motivation because savings are too small, uncertainty about level of benefits and costs (Is it worth informing myself?), other priorities, etc. Uncertainty about ability to reap the benefits: will the investment pay back before I move out? Lack of (access to) capital
Facility managers	It is their job to ensure a smooth and efficient operation of the facilities while minimising operating costs, which should include reducing energy waste to the extent possible.	The additional effort for energy (efficiency) management will not even be compensated nor rewarded, if fees for facility management are per m2 per year, and energy costs are paid separately by the building users
Employees, visitors, guests, etc.	Contribute to environmental protection Receive social recognition in return for environmentally-sound behaviour	No incentive for rational energy use as they do not have to pay the energy bills.
Welfare institutions on whom ability to pay rent depends	If the institutions pay directly for both base rents and energy costs, they should be willing to support energy efficiency improvements that reduce the total rent (base rent plus energy costs).	If the institutions only pay for the base rent and the tenants have to pay the energy costs from their lump-sum transfer, then the institutions will presumably be rejecting energy efficiency improvements as they increase base rents.
Public or social housing companies	Additional justification for institutional continuity Increase occupancy rates Increase the value of caring economical and living conditions for the (poor) population Contribution to national programms on sustainability and reduction of poverty Increase of the chance of care givers and of residents of working and living more sustainable Increase of (re-sale) value of the property Contribute to environmental protection	Investing in energy-efficient technologies is more expensive compared to conventional technologies → reduces potential to generate enough buildings, related to the demand by poor inhabitants No direct economic return from reduced energy bills: only tenants will save energy costs! Lack of knowledge about the demand for energy-efficient buildings: will citizens be interested and/or willing to rent a more energy-efficient apartment/ building? Lack of knowledge about options for making the building usable and caring economical-efficient more energy-efficient; is it worth the effort informing ourselves? (Perceived) lack of funds and / or other investment priorities Risk aversion towards new products/ technologies from new suppliers/ companies: will they offer the same quality, usability, caring economical and residen-

	Contribute to sustainable development Receive societal and political recognition in return for contribution to public duties of environmental and sustainable development	tial functionality, and safety?

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

2.2. 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 illustrates how the implementation strategies seek to influence each of the incentives and barriers identified.

Implementation strategy	**Incentives strengthened**	**Barriers tackled**
Ensure architects, property development companies, real estate agents, construction companies, and contractors that there is a market for ultra-low energy buildings	(Component manufacturers, manufacturers of prefabricated houses, system suppliers) Increase our revenue and profits by offering more expensive energy-efficient products or buildings (Architects, property development companies, manufacturers of prefabricated houses construction companies, and contractors) Present ourselves as innovative and gain competitive advantage (All supply chain actors) Improve our reputation by offering products/services that benefit both end-	(Architects) Need to change proven designs and constructions: will there be a market worth the effort? (Component manufacturers, manufacturers of prefabricated 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? (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? (Property development companies, manufacturers of pre-fabricated houses) 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 and low willingness to pay (more) for energy-

	users and the environment (Real estate agents, property development companies) Provided there is sufficient market demand for energy-efficient buildings, brokering or selling/letting such buildings increases revenues and (possibly) profits. (Landlords) Increase occupancy rates, opportunity to charge higher rents	efficient products/ buildings (Real estate agents, property development companies) Uncertainty about ability to find buyers/tenants for energy-efficient buildings (due to the higher rent/sales price)
Inform investors and capital providers 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 (Construction companies, contractors, property development companies) Extra construction cost: risk of losing customers to the competition (assuming that customers look at first cost only) (Capital providers) All barriers listed for capital providers in table on barriers
Fund demonstration projects and train architects, construction companies, and contractors about their technologies, solutions, and net savings	(Architects, property development companies, manufacturers of pre-fabricated houses, construction companies, contractors) Present ourselves as innovative and gain competitive advantage	(Architects, property development companies, manufacturers of pre-fabricated houses, construction companies) Will the energy-efficient house standard be achieved (risk of customer dissatisfaction)? (Architects, manufacturers of pre-fabricated houses, construction companies, contractors, investors) Lack of knowledge about (technical) options for making the building more energy-efficient: Is it worth the effort informing myself? (Architects, general management companies, construction companies, system suppliers/ installers) Liability for safety and functionality of the building/ installed systems (risk of customer dissatisfaction or even lawsuits) (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 choosing

		the energy-efficient solution
Buy/ bring down the first costs of new buildings more energy-efficient than the national building code (also via third-party financing or via market transformation/ economies of scale)	(Investors) Save energy costs	(Construction companies, contractors, property development companies) Extra construction cost: risk of losing customers to the competition (assuming that customers look at first cost only) (Investors) Lack of capital (Investors, tenants) Lack of motivation because savings are too small, uncertainty (Is it worth it?), other priorities, etc. (Investors) Present-biased preferences, uncertainty about ability to reap the benefits, excessive expectations in terms of payback (Property development companies, component manufacturers, manufacturers of pre-fabricated houses) Prevailing price competition or predominance of other product features over energy efficiency; therefore low priority and low willingness to pay (more) for energy-efficient products/ buildings
Increase motivation by making it as easy and attractive as possible (through the above implementation strategies) to choose the energy-efficient option; use social marketing tools (e.g., norm appeals, vivid personalized communication, obtaining a commitment, etc.)	(Investor-occupiers, tenants) Save energy costs (Investor-occupiers, tenants, employees, guests) Contribute to environmental protection (Investor-occupiers, tenants, employees, guests) Receive social recognition in return for environmentally-sound behaviour	(Investors, tenants) Lack of motivation because savings are too small, uncertainty (Is it worth it?), other priorities, etc. (Investors, tenants) Investment priority for core business activities (industry and tertiary sector) (Employees, guests, etc.) No incentive for rational energy use as they do not have to pay the bills
Highlight benefits (first of all achievable cost savings, but also non-energy benefits like improved comfort, health, productivity (commercial buildings)); show how others are already benefitting from EE measures	(Investor-occupiers, tenants) Save energy costs (Investors) Increase (re-sale) value of the property	(Investors, tenants) Lack of motivation, because savings are too small, uncertainty (Is it worth it?), other priorities, etc., lack of information about level and types of achievable benefits (Architects, construction companies, system suppliers/installers) Liability for safety and functionality of the building/ installed system (risk of customer dissatisfaction and potentially lawsuits)
Improve access to capital, e.g., through innovative financing mecha-		(Investors, tenants) Lack of (access to) capital

nisms		
Find ways to align opposing incentives in such a way that win-win situations occur		Landlord-tenant-dilemma (residential and tertiary sector) Developer-buyer dilemma (Architects) The usual calculation of fees as a percentage of construction costs creates incentives to plan buildings with more/larger installed systems than necessary; on top of that, the planning effort that would be needed to design an ultra-low energy building is not rewarded in such a system
Make energy efficiency the standard or at least reduce complexity by excluding the least efficient practices from the market		Developer-buyer dilemma Landlord-tenant dilemma (Investors, tenants) Lack of motivation because savings are too small, uncertainty (Is it worth it?), other priorities, etc. (Investors) Uncertainty about 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) (Architects, construction companies, contractors) Power of habit and good experiences with certain suppliers: if the energy-efficient components/ materials are only being offered by a new supplier there is uncertainty about his reliability and about the products' quality; is it worth the effort informing myself about new suppliers? (Capital providers) All barriers listed for capital providers in table on barriers
Change incentive structures so that chief executives also seek for long-term profit maximisation		Shareholders vs. chief executives (industry and commerce) → long-term vs. short-term profit maximisation
Qualification of supply chain actors so that they have the required knowledge to help customers choose (or finance) the most energy-efficient and cost-effective option		Lack of information by supply chain actors (sales staff, installers, architects, developers, etc., but also bank staff and other actors in the financial sector) about existence and performance of saving opportunities, cost-effectiveness of measures

Reduce transaction costs for investors		(Investors) Transaction costs of obtaining information as to: Which are the adequate and most cost-effective solutions for my building? Which architect/ contractor/ supplier offers the best value for money? What do I have to consider in terms of tendering, final inspection, etc.? (Investors) Lack of knowledge about options for making the building more energy-efficient; is it worth the effort informing myself? (Architects, construction companies, contractors) Power of habit and good experiences with certain suppliers: if the energy-efficient components/ materials are only being offered by a new supplier there is uncertainty about his reliability and about the products' quality; is it worth the effort informing myself about new suppliers?
Reduce uncertainties and build trust in energy-efficient building solutions		(Investors) Scepticism towards new products/ technologies: will they offer the same quality, functionality, and safety? (Investor-owners, tenants) Uncertainty about ability to reap the benefits: will the investment pay back before I move out? (Investor-owners, tenants) Uncertainty about level of benefits and costs
Enable capital providers to properly assess energy efficiency projects ("translate from technical to financial language")		(Capital providers) Uncertainty about how the investment will perform in terms of revenue and risk Lack of technical expertise and experience with this kind of projects (no performance track records available) Individual projects are too small to be interesting investments for equity funders; transaction costs of assessing risk and revenue for every single project are high The illiquidity and irreversibility of (most) energy efficiency investments increase the riskiness (IEA 2007, p.23). Not all benefits induced by energy efficiency improvement (e.g. reduced environmental costs, comfort increases, health improvement due to better indoor climate, etc.) are taken into account in traditional financial indicators (IEA 2007, p.23).

Table 2: Implementation strategies vs. barriers / incentives

2.3. 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 kick-starting a real market transformation in the building sector. This "ideal policy package" will be presented in the next section.

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

Implementation strategy	Policy package
Ensure architects, property development companies, real estate agents, construction companies, and contractors that there is a market	Long-term strategies/ political commitment for energy efficiency: e.g. Zero Net Energy targets and roadmap Information and advice programmes both for building investors and for architects, construction companies, and contractors Financial incentives for very energy-efficient new buildings (to increase the demand) Social housing investment to provide a first visible demand (i.e., 'Lead-by-example' programme in the public sector) Dynamic MEPS for buildings as a whole and for components/installed systems: 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
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 (enable the building designers and contractors to act as multipliers vs. the investors) Financial incentives for very energy-efficient new buildings (these also function as a quality mark and information tool) Mandatory Energy Performance Certificates for buildings as a whole and for components/installed systems, combined with an obligation for building owners to publish and present them when selling or renting out buildings or flats (to reach full impact, these measures should ideally be combined with implementation support: advice and financial incentives/ financing) Promotion of demonstration activities/ projects (to create convincing model examples) '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
Buy/ bring down the first costs of new buildings more energy-efficient than the national building code (also via third-party financing or via market transformation/ economies of scale)	Financial incentives for very energy-efficient new buildings (grants or subsidies or soft loans or tax incentives), incl. help on how to find and apply for them Promote Energy Service Companies (ESCOs); energy performance contracting schemes; third party financing; create guarantee funds for Energy Efficiency Service Providers Revolving energy efficiency funds with guarantee mechanisms Public Private Partnerships Public/ technology procurement programmes R&D funding
Increase motivation by making it as easy and attractive as possible to choose the energy-efficient option	Minimum energy efficiency performance standards (MEPS) for buildings as a whole and for components/installed systems (making energy efficiency easy by avoiding search costs) Motivation and information campaigns Information and advice programmes and centres Mandatory Energy Performance Certificates for buildings as a whole and for components/installed systems, combined with an obligation for building owners to publish and present them when selling or renting out buildings or flats Financial incentives for very energy-efficient new buildings (grants or subsidies or soft loans or tax incentives) (incl. help on how to find and apply for them), signalling that there is a beneficial opportunity Programmes providing subsidised assistance on energy efficiency during construction Use of behavioural approaches (social marketing, normative messages) Feedback measures (e.g., smart metering, informative/comparative billing, etc.) Professional training programmes Certification of qualified actors (e.g., energy consultants) Calculation tools for assessing costs and benefits over lifecycle taking risk and uncertainty into account (e.g. sensitivity analysis) Require use of LCC calculations on at least two design options Online database with most efficient products on the market
Highlight benefits, i.e. first of all achievable cost savings, but also non-energy benefits like improved comfort, health, productivity (commercial buildings); show how others are already benefitting from energy efficiency	Information/advice programmes highlighting cost-effectiveness Public disclosure and rankings of achieved energy and cost savings (including but not only demonstration projects) Use of behavioural approaches (social marketing, normative messages, e.g. frame recommendations in terms of money lost (or opportunity missed) through inaction rather than in terms of possible gains through action) Informative/comparative billing Promotion of demonstration projects/activities Energy efficiency networks/clusters

measures	
Improve access to capital, e.g., subsidise energy efficiency measures, establish innovative financing mechanisms	Financial incentives for very energy-efficient new buildings (grants or subsidies or soft loans or tax incentives) (incl. help on how to find and apply for them) Co-operation with banks (incl. training for bank staff) Support of energy performance contracting (EPC) schemes backed up by credit financing, guarantee schemes, leasing, forfeating, etc. Third-party financing schemes such as on-bill financing, property tax financing, Pay As You Save schemes Revolving energy efficiency funds with guarantee mechanisms Public Private Partnerships
Find ways to align the opposing incentives of landlords and tenants / developers and buyers in such a way that win-win situations occur	Mandatory Energy Performance Certificates for buildings as a whole and for components/installed systems, combined with an obligation for building owners to publish and present them when selling or renting out buildings or flats MEPS for buildings as a whole and for components/installed systems Different measures to increase trust in win-win situations (e.g. disseminating and highlighting research results that show there is a rent and sales price premium for energy-efficient buildings; emphasising cost-effectiveness of energy saving measures) Revision of landlord and tenant laws: allow to increase the rent without energy costs for recovery of prudent and cost-effective investment that decreases 'total rent' including energy costs Third-party financing schemes such as on-bill financing, property tax financing, GreenLeases/ Pay As You Save schemes Integration of energy efficiency aspects in property valuation tools
Make energy efficiency the standard or at least reduce complexity by excluding the least efficient practices from the market	MEPS for buildings as a whole and for components/installed systems Requirements to properly commission new buildings, to establish energy management systems (incl. regular consumption measurement) and to perform regular inspections and maintenance
Change incentive structures so that chief executives also seek for long-term profit maximisation	Require companies by law to change internal incentive structures MEPS for buildings as a whole and for components/installed systems Requirements to properly commission new buildings, to establish energy management systems (incl. regular consumption measurement) and to perform regular inspections and maintenance Sectoral voluntary agreements / target setting coupled with financial incentives Energy efficiency networks/clusters
Qualification of supply chain actors so that they have the required knowledge to help customers choose the most energy-efficient and cost-effective option	Integrate information about available energy saving options (technological, organisational and behavioural) and their cost-effectiveness into education and training for architects, developers, construction companies, installation contractors, facility managers, real estate agents and other intermediaries Development of specialised professional training programmes about energy efficient buildings and construction Development and distribution of standardised teaching material Certification of qualified actors (e.g., architects, energy consultants) Provision of standardised material for dissemination, e.g. brochures, tools for calculating/demonstrating cost-effectiveness to building owners/investors

	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 Online database with most efficient products on the market
Reduce transaction costs for investors	Energy advice and consultancy (including advice on financing opportunities and measure implementation) Programmes providing subsidised assistance on energy efficiency during construction Mandatory energy performance certificates, combined with an obligation for building owners to publish and present them when selling or renting out buildings or flats Calculation tools for assessing costs and benefits over lifecycle, taking risk and uncertainty into account (e.g. sensitivity analysis) Online database with most efficient products on the market Certification of qualified supply chain actors and providing access to lists of certified actors
Reduce uncertainties and build trust in energy-efficient building solutions	Calculation tools for assessing costs and benefits over lifecycle, taking risk and uncertainty into account (e.g. sensitivity analysis) Focused information and motivation campaigns and their tools (websites and tools, print and TV ads, brochures, etc.) Public disclosure and rankings of achieved energy and cost savings of buildings / systems Certification of qualified supply chain actors Promotion of demonstration projects
Enable capital providers to properly assess energy efficiency projects ("translate from technical to financial language")	Development of tools/models that make it possible to assess the financial performance of energy efficiency investments Calculation tools for assessing costs and benefits over lifecycle, taking risk and uncertainty into account (e.g. sensitivity analysis) Education and training for bank staff, including on use of the tools Promotion of demonstration projects

Table 3: Implementation strategies vs. policy packages

3. 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 one operational goal: make ultra-low-energy buildings (ULEB) the standard in new construction. This can save 60 to 90 % of energy compared to new conventional buildings at costs below market-based energy prices, create enormous job opportunities, and de-

couple growth from energy consumption and greenhouse gas emissions in the buildings sector. 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.

4. 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.

4.1. 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.

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

Appropriate 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-effective, 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

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

4.2. 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).

5. 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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