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ScienceDirect

Energy Procedia 96 (2016) 363 – 374

Energy Procedia

SBE16 Tallinn and Helsinki Conference; Build Green and Renovate Deep, 5-7 October 2016, Tallinn and Helsinki

The chain of effects of energy retrofit measures – a contribution to the project RentalCal

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Abstract

Further improvements of the buildings stock's energy performance are a necessary precondition to achieve Europe's climate and energy policy objectives. Hereto, many investors need to overcome their insecurities regarding the profitability of such measures. As a contribution to the EU-project RentalCal, in this paper it is discussed and illustrated, what consequences result from energy performance improvements of existing buildings and how they influence cash flow and real estate value along a chain of effects. In particular, explanatory patterns and lines of arguments which complement and interpret empirical evidence are developed.

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Peer-review under responsibility of the organizing committee of the SBE16 Tallinn and Helsinki Conference.

Keywords: Energetic Retrofit; Refurbishment Measures; Residential Rental Dwellings; Germany; Non-Monetary Benefits; Chain of Effects; Financial Performance; RentalCal Project

1. Introduction and context

In 2013, the member states of the European Union consumed more than 46 exajoules of end energy (more than nine exajoules in Germany), simultaneously emitting 4.824 megatons of CO_2-equivalents (Germany: 972,9) [1]. In Germany, the building sector accounts for about 38% of the final energy consumption [2], with space heating for households as main part of consumption; in Germany almost 1.8 exajoules (EU: 8.37) [3]. Consequently, reducing the energy demand for heating (particularly space heating) is an obvious and straightforward way to reduce the EU's

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Peer-review under responsibility of the organizing committee of the SBE16 Tallinn and Helsinki Conference.
doi:10.1016/j.egypro.2016.09.160

and especially Germany's energy consumption and greenhouse gas emissions. For those reasons, the European Commission Roadmap for 2050 states that "emissions in this area could be reduced by around 90% by 2050" and that "new buildings should be designed as intelligent low- or zero-energy buildings" [4]. But building more energy efficient houses is far from enough, as there is a much larger building stock that already exists. These buildings date back to various construction years and their energetic performances vary wildly. As the largest part of heating energy can be saved in the existing building stock, there is much emphasis on (energetic) refurbishments. The European Commission's Roadmap states that "over the next decade investments in energy-saving building components and equipment will need to be increased by up to € 200 billion" [5].

A large share of the buildings in question are possessed by private persons, ownership communities or enterprises, so it is necessary to motivate them to invest into their buildings' energetic performance and in most cases, this may only be done successfully, if it is possible to convince the owners that a refurbishment is profitable for them. For owner-occupiers, potential benefits primarily comprise savings in heating expenses. However, at first glance there seem to be only minor benefits from energetic retrofits for private landlords and housing companies, as operating costs are usually borne by their tenants.

Hence, the EU-founded horizon 2020 project RentalCal assesses the impacts of energy efficiency refurbishments of existing buildings on landlords' cash flows, building value and profitability within its scope. The projects' purpose is to improve market transparency for energy efficiency investments in the rental housing industry by providing a tool for the profitability assessments of energetic refurbishments, thereby supporting the housing industry, energy consultants and especially private landlords. Moreover, specific information is provided to the individual target groups in national housing markets. Eventually, the developed methodology can be used for a transparent comparison of investment conditions in different EU countries to foster the market harmonisation process to remove investment barriers in national housing markets. In the long run, this should contribute to an increase in investments into efficiency and sustainable energy in the building sector. The RentalCal consortium consists of 11 partners from 8 European countries. See *http://www.rentalcal.eu/* for further information.

There are many effects from energy efficiency measures that directly or indirectly benefit stakeholders in the context of housing and their relation is not straightforward. One of the objectives of this paper is to identify and analyse all direct and indirect impacts of improvements in energy performance and to assign them to the stakeholder groups they finally benefit. Hereby, the question whether effects are direct or indirect, depends on the perspective of the respective stakeholder, particularly tenants, landlords and environment/society. It shall be illustrated in detail how direct benefits from the tenants' perspective result in indirect benefits for landlords. Then it is evaluated, whether the benefits contribute to the fulfilment of stakeholders' individual or institutional objectives.

The most immediate impacts from the implementation of energy refurbishment measures are reduced demands of (non-renewable primary and/or final) energy and simultaneous reductions of GHG emissions and air pollutants. Examples for indirect benefits (from landlords' point of view) which result from those measures are rent increase leeways due to reduced heating expenses and improved user satisfaction for tenants.

Numerous studies argue in favour of an overall profitability of energy efficient buildings (cf. for example [6,7,8]), especially when it comes to office buildings in Anglo-Saxon countries (e.g. [9,10,11]), but much less focus on rental residential buildings (e.g. [12,13]). Considering empirical investigations, most studies try to relate energetic performance (or certificates for energetic performance) to rent levels (e.g. [14]) but not to overall profitability of the entire refurbishment investment. Moreover, the complex and intricate processes how individual measures within an energy retrofit actually impact rents or even economic advantageousness, are usually excluded.

This paper tries to identify and systemize the individual partial effects that are caused by measures usually taken in energy efficiency refurbishments and to retrace, in which ways they lead to improved conditions for tenants or landlords and contribute to a better economic performance. Then, the sequence of impacts is summarised and visualised in a chain of effects.

Nomenclature

Refurbishment measure	A structural modification in a building's envelope, heating system, domestic hot water and energy supply etc. Usually, several energy efficiency measures are carried out simultaneously as a "package of measures" together with renovations/repairs that are necessary in the building's life cycle anyway. As this paper emphasizes the benefits of energetic retrofit measures, only measures are considered whose main purpose is a decrease in (non-renewable) primary energy consumption.
Effect	A noticeable or quantifiable consequence of an energy refurbishment measure or a preceding effect.
Benefit	A noticeable or quantifiable final improvement of circumstances for a tenant, landlord or other stakeholder in the context of rental habitation as a consequence of an effect, a sequence of effects or a measure that was intended to yield that improvement.
Additional benefit	A noticeable or quantifiable final improvement of circumstances for a tenant, landlord or other stakeholder in the context of rental habitation as a consequence of an effect, a sequence of effects or a measure that was not primarily intended to yield that improvement.
Chain of effects	A qualitative sequence from a measure or bundle of measures via their direct and subsequent effects up to their direct and additional benefits and their monetary and non-monetary impacts for the landlord/building owner.

2. Starting point and state of research

The authors couldn't identify a study which described a comprehensive, detailed chain of effects from energy retrofit measures to individual benefits for tenants and landlords yet, but there are several strands of literature regarding the effects and benefits of energy performance improvements. Some of them mainly collect qualitative benefits and occasional pieces of data that support individual claims but don't get to a thorough profitability analysis. These writings usually exhibit an elaborate design and are directed to practitioners and try to convince them to consider and opt for deep retrofits by supplying favourable polls, quotes, arguments or case studies. Many of these texts originate in the U.S. and emphasize office or commercial buildings, like Deloitte's [15] or the RMI's brochures [16,17,18], but there are also examples for Germany [19] and other European countries [20].

When it comes to residential housing it is necessary to differentiate rental dwellings from owner-occupiers'. In the latter case, the proprietors are also inhabitants, thus all expenses and benefits coincide, which makes analysis more straightforward. There are plenty of studies which emphasise the overall profitability of energy efficiency measures regarding owner-occupied dwellings, particularly if they are bundled with refurbishments that where due anyway. Examples for Germany are [21,22,23].

In case of rental housing, profitability evaluations are more complex, as investment costs are (at least in Germany) generally borne by the building owners, while most direct financial benefits (like heating cost savings) accrue to the tenants and it is not straightforward to tell that the investors necessarily obtain additional revenues from them, let alone enough to offset their initial expenses or make profits. Despite this "landlord-tenant problem" (for an elaborate explanation of this problem in the context of principal-agent-problems in general, see for example [24]), profitability assessment of rental housing is necessary and there is an extensive field of studies that try and find empirical evidence for the financial benefits of buildings' energy performance or energy retrofits (for an extensive compilation of relevant studies, see [25]).

Usually, these analyses use energy certificates or energy performance as independent variables and try to determine their impact on dependent variables like overall profitability, building value or – as in most cases – rent revenues. For example, Figure 1 illustrates the average effects of energy performance improvements on rents and sale prices for a selection of European markets.

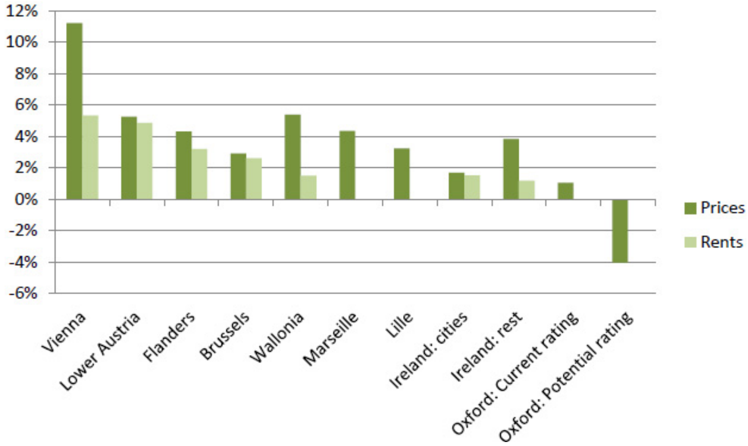

Fig. 1: Effect of one-letter or equivalent improvement in EPC rating across a selection of European property markets; Source: Bio Intelligence Service, Ronan Lyons & IEEP 2013 [25]

Again, the main part of the studies scrutinise office or commercial buildings in Anglo-Saxon countries, but there are also examples for the German rental housing market [26,27]. However, as such empirical studies are designed to detect significant links between measurable energetic performance or appropriate proxies and outcomes like rent level or profitability, they can't and don't present extensive explanations how these effects come about and how benefits from individual measures propagate to eventually cause an impact on the dependent variable. Moreover, if considered alone, these studies are not sufficient to evaluate whether investments into the energy performance of rental residential buildings will turn out profitable, because they usually don't take the expenses to reach those levels of energy performance into account. This is the point where the RentalCal projects steps in, as its assigned task is to provide an accessible software tool to evaluate the profitability of energy retrofits for individual buildings.

The present paper contributes to this project. In particular, it shall be clarified which immediate consequences (from the landlords' perspective) relate to measures for energy performance improvement of existing buildings and via which chains of effects they affect cash flow and value development of rented residential properties. In the context of the RentalCal project, the findings presented in this paper help to identify all important effects and benefits that investors should take into account to make thorough analyses and decisions and communicate them to the stakeholders involved.

3. General concept

In order to get to a thorough understanding how measures taken within an energy efficiency refurbishment impact various stakeholders, especially owner-occupiers, tenants and landlords, several common measures that are oftentimes parts of energy retrofits are described and connected to the direct consequences resulting from them. Then, the repercussions that result from measures' consequences are depicted and linked to the individual stakeholder types which directly benefit from them. The next step is to identify how those benefits condense into economic benefits for landlords.

As a consequence, a complex and continuous chain of effect traces the manifold impacts of energy efficiency measures to final monetary and non-monetary results for the stakeholders involved. Moreover, the numerous benefits of energy efficiency measures and how they are allocated to specific stakeholders are pointed out. In the first instance, Figure 2 shows an abstract model of a schematic chain of effects.

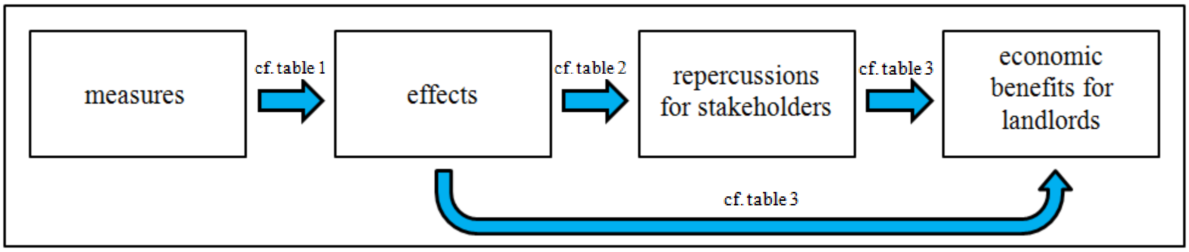

Fig. 2: Chain of effects from energy retrofit measures to economic benefits

It becomes clear that (technical, respectively structural) measures aimed at energy performance improvement result in effects (here: effects on environment, inhabitants, the building itself, etc.) which can be identified and described. In a second step, those effects are attributed to stakeholder groups (here: landlords, tenants, environment, economy, etc.). Finally, it is discussed which effects can be related directly or indirectly to economic benefits for landlords.

4. Measures, effects and benefits for tenants and building owners

4.1. Usual measures and their immediate impacts

The first step in the assessment of impacts of a deep energy retrofit is to identify measures that are usually taken, for example improvements of the building envelope like insulations of exterior walls, basement ceilings or perimeters, attic floors or roofs and the replacement of windows. These measures help to diminish domestic heat loss to the environment and prevent overheating in summer. As a consequence, less energy is required to maintain comfortable living conditions constantly, thereby reducing energy demands and increasing thermal comfort. Moreover, given sufficient ventilation and no thermal bridges, additional insulation prevents the condensation of damp and thus reduces the risk of black mould formation.

On the other hand, additional exterior insulation of walls influences the building's design quality – and not necessarily for the better. Also, if (for example due to monumental protection restrictions) insulation must be applied to interior walls, available living space decreases and risks regarding building physic emerge.

Other popular measures aim at the heating system, like the replacement of pumps or burners or the insulation of tubes. These measures make heat generation and distribution more efficient and focused, likewise reducing final energy demand and emissions. Furthermore, a change of energy carriers and the application of renewable energy might reduce the demand for primary energy and thus emissions of greenhouse-gases and air pollutants. The impacts of the installation of a ventilation system depend on the system's dimension and setting: A ventilation system of appropriate size helps to maintain pleasant thermal comfort and air quality in the building and keeps humidity on a benign level [28]. This is particularly important if retrofit measures require an adjustment of ventilation habits. In a leaky building with draught, excess humidity is channelled out almost automatically. But in energy refurbishments, leaks are usually sealed while damp production stays the same. Thus, residents regularly need to air manually to keep humidity between 40 – 55 % during the heating period. If they don't, moisture and black mould risk increase instead of decrease. The installation of an automatic ventilation system relieves this responsibility from the residents and if the system provides heat recovery, it also decreases heating energy requirements (while increasing operating expenses in some cases). However, if the ventilation system is oversized, it will decrease humidity in winter below comfortable levels and unduly contribute to the electricity bill, annihilating savings in energy and emissions. Anyway, an additional ventilation system will increase the maintenance expenses for the building.

Table 1 illustrates the individual measures and their consequences for various circumstances in the context of housing.

Table 1: Benefits of measures for the subsequent improvement of existing buildings' energy performance

Impacts and consequences \ Measures	Additional insulation of exterior walls [4]	Additional insulation of ceilings (basement ceiling / attic floors)	Replacement of windows	Replacement of the heating system (e.g. pump / burner replacement)	Energy carrier exchange	Application of renewable energy	Installation of a ventilation system
Final energy savings	+	+	+	+			+/- *
Primary energy savings (non-renewable) [1]	+	+	+	+	+	+	+/- *
Reduction in greenhouse-gas emissions [2]	+	+	+	+	++	+++	+/- *
Reduction in air pollutant emissions [3]	+	+	+	++	++	+++	+/- *
Improvement of thermal comfort in winter	+	+	+				(+)
Improvement of thermal comfort in summer	+	+	++				(+)
Building structure protection	(+)						
Effect on the quality of design	+/-						
Effect on rentable space	+/-	(+/-)			(+)		(-)
Improvement of indoor air quality							+
Reduction of condensation damp / black mould risk	+	+	(-)[x]				+ **

* Oversized ventilation systems could cause an increase in electricity consumption.
** Oversized ventilation could cause unsolicited reductions of humidity in winter.
[x] The installation of tight windows could increase the risk of black mould.
[1] Contribution to resource conservation.
[2] Contribution to climate protection.
[3] Contribution to the improvement of the local air quality.
[4] Interior wall insulation reduces living space and causes structural damage risks.

Moreover, there are plenty further effects of energy efficiency refurbishment measures with impacts and consequences to eventually benefit stakeholders. For example, the guide published by the Rocky Mountain Institute suggests that investing in energy retrofits or even targeting efficiency beyond legally mandated levels entitles investors for grants, subsidies or subsidised lending and might result in decreasing insurance costs and additional available space e.g. due to downsized or obsolete equipment [29]. However, it should be noted that some measures like insulation of interior walls or the installation of ventilation systems can also diminish rentable space.

4.2. Mediate impacts of measures

In this section, the immediate impacts of measures described above are connected to their subsequent mediate effects. Moreover, impacts are differentiated by beneficiaries and their point of view.

For example: final energy savings due to better insulation, a change in energy carriers and the application of renewable energy result in a reduction of heating costs, benefitting both owner-occupiers and tenants but not landlords (at least in Germany, as in German rental contracts, operating expenses are typically borne by tenants). On the other hand, all measures which contribute to primary energy savings help to conserve non-renewable resources, benefitting the entire society, but corporate landlords particularly as they can publish their efforts in their CSR reporting and contribute to their corporate image. Simultaneously, the reduction in greenhouse-gas emissions resulting from less fossil fuels burnt benefits the environment and especially efforts to mitigate climate change.

Again, besides societal benefits, corporate landlords can use their efforts in their CSR reporting [30] and enhance their reputation [31].

In certain cases, additional insulation protects building structures and may lead to an extended lifespan of building parts which benefits building owners, as they can use their structures longer, respectively prolongate modernisation/replacement cycles and delay related expenses. Where existing structures have longer useful lives and maintenance/replacement efforts can be avoided, there are also benefits for environment and society.
Improvements in thermal comfort and indoor air quality both in summer and winter resulting from better insulation, tight windows and ventilation benefit the dwellings' inhabitants, namely owner-occupiers and tenants, by increasing their user satisfaction. Moreover, if appropriate insulation and ventilation reduce condensation damp and the risk of black mould formation, that benefits both owner-occupiers and tenants as inhabitants, but also owners, as it protects the buildings' structures from mould-induced damages. However, it should be noted that additional or more complex building equipment could increase operating expenses like maintenance costs. This burdens owner-occupiers and either landlords or tenants, dependent on whether they are apportionable under the respective circumstances and jurisdiction.

Table 2: mediate impacts of measures

Impacts of measures	**Effect occurs for**				
	Repercussions	**Owner-occupier**	**Landlord**	**Tenant**	**Society / Environment**
Final energy savings	Heating cost reductions	x		x	
Primary energy savings (non-renewable) [1]	Conservation of resources				x
	Corporate image	(x)	x		
Reduction in greenhouse-gas emissions [2]	Environmental relief				x
	Corporate image	(x)	x		
Reduction in air pollutant emissions [3]	Environmental relief				x
	Corporate image	(x)	x		
Improvement of thermal comfort in winter	User satisfaction	x		x	
Improvement of thermal comfort in summer	User satisfaction	x		x	
Building structure protection	Extended lifespan of the envelope	x	x		(x)
Effect on the quality of design [32]	Sentimental value	x	(x)	(x)	(x)
Improvement of indoor air quality	User satisfaction	x		x	
Reduction of condensation damp / black mould risk	User health	x		x	
	Building structure protection	x	x		
Increased maintenance expenses for additional building equipment (HVAC)	*increased non-apportionable operating costs*	x	x		

1 Contribution to resource conservation.
2 Contribution to climate protection.
3 Contribution to the improvement of the local air quality.

Table 2 illustrates the repercussions of direct impacts of energy retrofit measures and whom they benefit.
It becomes clear that the individual categories are clearly attributable to specific groups of stakeholders.

4.3. Economic consequences of improved energy performance

In the last step of the chain of effects, the final economic consequences are illustrated. Some benefits for the owner-occupiers or landlords influence their cash-flow, others increase the value of their houses (though it's possible that some don't intend to ever sell their property). Many impacts might also affect consequences that are non-monetary or cannot be quantified, like sentimental value or reduced health risks [33,34,35]. Still, these are real effects of energy refurbishment measures and strongly affect the stakeholders involved, so they should be taken into account as additional information or arguments when making an investment decision.

Some of the most straightforward and quantifiable monetary consequences result from rent increases that where made possible by the energy efficiency investment. In Germany, one opportunity for landlords to legally increase rent is to raise it by an apportion of modernisation cost [36]. Another possibility relates to rent indices and customary comparative rents [37]. As many rent indices in Germany provide surcharges based on energetic quality, they also allow for rent increases dependent on the new energetic performance. Besides the legal opportunities for rent increases, energy retrofits also make higher rents feasible as they make apartments more attractive for potential and current tenants. Moreover, as heating costs for tenants decrease, it is possible to shift payments from heating costs to rent within the gross rent without additionally burdening tenants.

Moreover, dependent on market situation and the valuation method applied, rent increases and more reliable payments might result in enhanced building value stability and development, both because current and expected rent revenues increase, but also because the building's useful life span is extended. For example, in his study of real estate sales prices, Wameling (2010) found apartment buildings with lower heating energy demand to sell at higher prices per m² [38].

The reduction in heating expenses for tenants benefits landlords not only because in many cases they are able to charge higher rents, but also that their risk of rent losses due to insolvent tenants decreases as tenants have more disposable income, resulting in a more steady cash flow.

Another possible benefit for landlords is a reduction in vacancy rates [39,40,41,42] (also c.f. [43] for occupancy rates in office buildings) and extended lease periods, as both potential and existing tenants are attracted to the low heating costs, healthy living conditions and high user satisfaction due to pleasant thermal comfort and indoor air quality. According to a survey by Banfi et al. [44], tenants and owners are willing to pay for improved air quality, thermal comfort and protection against noise (thick insulation and tight triple-layer-windows might absorb noise from outside). A reduction in vacancy and extended lease periods generate additional revenues for landlords and reduce administration expenses due to tenant turnover and non-apportionable operating expenses attributable to vacant dwellings.

If the envelope is insulated and tenants ventilate their dwellings accordingly (or a ventilation system takes care of this), the risk of black mould and resulting structural damage risks are reduced, decreasing maintenance and repair costs and protecting the building structures.

Not only landlords benefit in the chain’s last link, but also environment profits from reduced pollution and society benefits from reduced primary energy demand (and consequently less energy imports) and reduced public health expenses due to healthier living conditions.

As corporate landlords could use the conservation of resources, environmental relief and improved user health caused by their investments in CSR reports and improve their corporate images, it is possible those measures even enhance their goodwill.

Table 3 connects the effects of measures as carved out so far to the economic benefits for landlords finally resulting from them and also illustrates the interdependencies involved: Extended lease periods and rent increases, just like reduced vacancy and rental loss risks contribute to property value stability and value increases (dependent on valuation method). In cases of large corporate or municipal investors that own majorities of dwelling units in quarters, there could be even noticeable impacts on location quality. For example, if energy refurbishment of most buildings in a quarter enhances overall air quality or renovation of facades (after insulation of exterior walls) improves the district’s design quality, all properties in it might undergo an upgrade in valuation.

Table 3: Economic consequences of improved energy performance

Economic consequences …	**… are due to**							
	Improved energy performance	Reduction in heating expenses	Conservation of resources	Environmental relief	Image enhancement	Health / user satisfaction	Building structure protection / durability / useful life	*Interdependencies*
Rent increase (by modernisation apportionment, energetic quality surcharges according to rent index, feasibility of higher rents, shifts from heating costs to rent within the gross rent (rent incl. heating)	x							
Value stability and increase (due to higher rents in (German) income approach, due to extended (remaining) useful life, due to discounts because of modernisation backlog)	x							
Reduced rental loss risk (due to reduced energy expenses, tenants can afford rent payments more easily from their disposable income); steady cash flow		x						
Reduced vacancy risk (amongst others due to improved thermal comfort, reduced heating costs etc.)		x				x		
Extended lease periods (due to increased user satisfaction)		x				x		
Reduced risk of damages due to black mould							x	
Increased goodwill due to positive sustainability reporting			x	x	x	x		
Reduced health expenses in the economy						*x*		
Reduced external effects from environmental pollution				*x*				
Reduced dependence on imports of energy carriers			x					

Eventually, the impact of deep energy retrofits on building value depends both on valuation methods and whether real estate valuation experts are willing and able to value outstanding energy performance. If some kind of net present value is applied, increased rent revenues and expected revenues, together with an extended useful life should increase the building value. If asset value method is applied, the increased replacement cost of windows, insulation and ventilation system, together with the extended remaining useful life should boost property values. Regarding sales comparison methods, the impacts of energy efficiency retrofits on valuation depend on the sales prices of comparable buildings. However, whether and how energy performance enters this comparison and how it is valued in the subsequent evaluation of individual features depends on valuation experts' procedure, level of knowledge and capabilities.

As a consequence, there have been efforts to equip real estate valuation experts with tools to assess the value of buildings' sustainability performance. One example is the "NUWEL" ("Nachhaltigkeit und Wertermittlung von Immobilien") guideline that has been created by a team of authors from Germany and Switzerland to provide practical support to valuation professionals, show which sustainability features of real estate influence its value and how this influence could be taken into account within customary valuation methods [45].

Moreover, the RenoValue project which was funded by the Intelligent Energy Europe Programme of the EU was directed to the development of a training toolkit for real estate valuation professionals. The RenoValue toolkit provides them with support on how to factor energy efficiency and renewable energy issues into valuation practices and advise their clients accordingly [46].

5. The chain of effects

Figure 3 provides the synthesis of the interrelations depicted in the three tables above for measures regarding the replacement of windows, insulation of the opaque envelope and installation of a ventilation system with heat recovery. The complex interdependences how these measures lead to direct effects, repercussions for the stakeholders and finally to those economic consequences which benefit landlords, are illustrated by a system of arrows which represent the direction and sign of individual relationships.

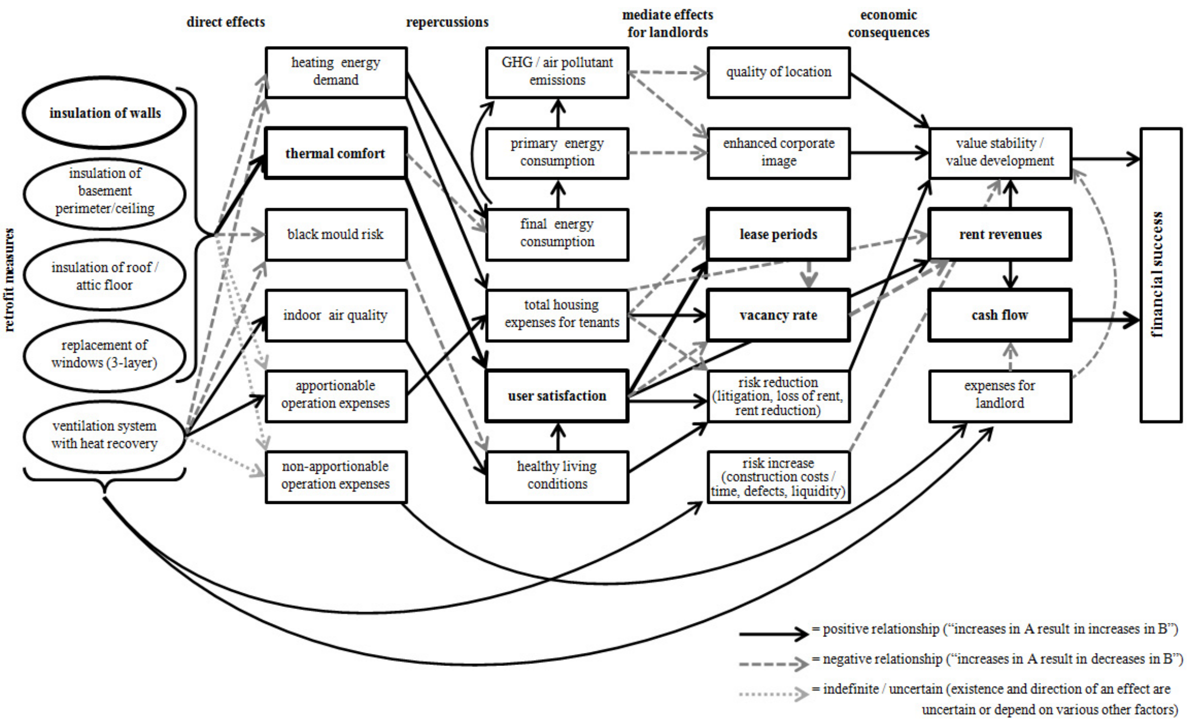

Fig. 3: Chain of effects for envelope-related measures and ventilation system. (assumption: ventilation system installed and run appropriately)

6. Conclusion and recommendations

In the present paper, the complex and manifold ways how energy efficiency refurbishment measures influence the stakeholders involved and particularly building owners and landlords, were described and illustrated in a chain of effects. It has been shown that analyses trying to assess the impact of energy performance on building owners' financial success which only take decreases in (non-renewable primary) energy into account fall short of the actual effects. There are more factors contributing to and representing consequences of energy refurbishment investments and they are interconnected in a sophisticated system. In order to get an expectation of whether a specific investment into an individual building will turn out profitable, it is necessary to evaluate the entire chain of effects with the consequences for existent and future tenants and maybe even quarters or society as a whole.

This paper presents a qualitative analysis, though it is far from specifying precise values. To get a precise, reliable and even quantifiable impression of the eventual impacts of energy retrofits on owner-occupiers' and landlords' economic outcomes, more research on the specific partial effects and tenants' willingness to pay for improvements in individual features of housing is needed. For example, air quality, thermal comfort, absence of black mould and affordability of housing exert considerable effects on inhabitants' mental and physical health, which could be attributed immense personal and societal value. However, these features have hardly been quantified on individual levels and are barely represented in tenants' willingness to pay or in hedonic regressions of real estate values. If there were more knowledge about these important impacts and they would be communicated more broadly, there could be additional incentives for energy efficiency refurbishments.

In Germany, there are rent indices for many cities and rents levels are – to a certain degree – based on them. Some of those indices even include surcharges for energy performance or features which improve it. These surcharges might result from reduced heating energy demand and thermal comfort, but also hygiene and indoor air quality. However, the according values are derived from market rents, though don't necessarily represent all actual benefits provided by high energetic quality. If the additional potential benefits of energy refurbishments, particularly health benefits, would be integrated into rent indices or communicated in other certificates, those benefits could be taken into account a lot more by tenants considering their willingness to pay.

Likewise, the multiple benefits of energy retrofits need to be communicated to real estate valuation professionals who should take them into account more thoroughly.

Then eventually, the expectations about the financial performance of energy efficiency investments could match their actual complex impacts much more.

The aforementioned RentalCal project is supposed to last until February 2018. However, the calculation tool which is intended to support landlords and energy consultants in investment decisions about energy efficiency refurbishments might be available earlier, not later than August 2017. The RentalCal tool will help investors to assess the multiple benefits that result from energy retrofits, particularly rent increases due to reduced heating energy demand, but it will also point to additional benefits as presented in this paper. Eventually, landlords can make a more qualified, holistic and thorough analysis of their investment opportunities and their consequences and take them into account.

Acknowledgements

The authors would like to thank the EU for the funding (H2020-EE-2014-2015: H2020-EE-2014-3-MarketUptake) and the member organisations of the RentalCal consortium, namely the Institut Wohnen und Umwelt (IWU) Darmstadt, the University of Regensburg, the STÚ-K a.s. company in Prague, the Aalbourg University, the European Green Cities Network, the University of Alicante, DELPHIS, the Tilburg University, the National Energy Conservation Agency (NAPE) Warszawa and the University of Cambridge.

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