Multiple benefits as incentive for municipal climate mitigation efforts? The case of a German shrinking and aging middle size city

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Abstract

Energy efficiency in residential buildings has increasingly presumed importance in meeting the global challenge of promoting sustainable use of energy resources while fulfilling substantial CO_2 emission reduction goals. Municipalities are often said to be the protagonists in determining the quality and pace of energy-efficient refurbishment of buildings (e.g. Barrutia and Echebarria 2013). At the same time, climate-change mitigation also poses a problem for collective action. This implies the need to understand possible motivations for municipalities to promote energy efficiency measures. Even though the multiple benefits of buildings renovation are increasingly highlighted by major research institutions such as the Intergovernmental Panel on Climate Change (IPCC) and other intergovernmental bodies such as the International Energy Agency (IEA) (Lucon et al. 2014, OECD/IEA 2014) little work has been done to address the local dimension of the community-wide benefits that result from increasing energy efficiency by refurbishment. Therefore, this paper presents a contextual approach by assessing the macro-economic impacts on municipalities from energy-related renovation measures. It provides a single case study of the shrinking and aging middle-size city of Delitzsch in Saxony, Germany. The analysis is divided into three parts and is based on the authors' previous work (see Gröger 2014, Verhoog 2013): Firstly this study takes a modeling approach in which renovation scenarios are designed that distinguish between the renovation behavior of landlords and that of home owners. Landlords tend to take into account the techno-economic optimization potential for renovations, while home owners renovation activity is more likely influenced by socio-economical factors, derived from lifestyle-data. Secondly, the scenario effects on the municipality are evaluated. Factors such as municipal tax revenues, local employment effects, avoided energy imports as well as the ecological impact are analyzed. The investment and ecological effects of energy-related refurbishment are determined through the integrated scenario-based energy modeling tool DESCoM (Gröger 2013); while welfare effects are estimated on the basis of literature research. The third part takes a qualitative survey approach: it summarizes the results of interviews among mayors of municipalities with decreasing and aging population in Saxony on their perception of benefits from an energy transition. It assesses in this way how mayors know and believe in the multiple benefits approach. Finally, this study concludes that municipalities confronted by difficult conditions can also expect considerable positive economic impacts when they provide incentives to carry out energy-efficiency renovation. A central result of this research shows that these benefits are not yet identified by decision makers of shrinking and aging middle size cities.

Local solutions for a global problem

To successfully address the challenges of meeting the goals of serious climate change mitigation as well as the implied need to reduce CO_2 emissions, the energy sector needs to undergo a comprehensive transformation process, which requires the involvement of all relevant actors at all levels. Taking into account the tedious on-going negotiations at the international level, actions on local levels are of increased importance. Hence, cities, municipalities and their governments play a significant role as local actors (Collier 1997, Ostrom 2002, Ostrom 2010). Municipal governments have the ability to implement measures and targets, for which no consensus can be achieved on a national and international level. In addition, many of the decisions taken at the international level and beyond must be implemented locally. While a great potential is attributed to the municipalities, it is not clear which specific benefits these urban entities are gaining in climate change mitigation (Bulkeley 2010, Sippel and Jenssen 2009).

Cities and municipalities are responsible for about 75 % of the global energy consumption, much of it related to the building sector and this with increasing tendency (Oliviera Fernandes et al. 2011). Therefore, energy efficiency in residential buildings has been increasingly presumed important to meet the global challenge of sustainable use of energy resources while achieving substantial CO_2 emission reduction goals. Nevertheless, efficiency goals in the building sector seem to be hard to achieve. To change this, the academic debate has dealt with issues related to the techno-economic feasibility of renovations as well as to the non-rational decision paths of home owners (Gröger et al. 2011).

But homeowners and tenants are not the sole beneficiaries of an energy renovation. A multiple benefits approach needs to be discussed (Ostrom 2010), which is also highlighted by major research bodies and international agencies such as the IPCC and the IEA (Lucon et al. 2014, OECD/IEA 2014). This approach takes into account the different types of beneficiaries. Some effects relate e.g. directly to home owners or tenants such as direct energy savings resulting from lower energy bills. Other effects have long term societal implications such as poverty reduction or air quality improvement. From a global perspective, energy renovations contribute to the reduction of global greenhouse gas emissions. Positive overall externalities surpass in many cases the costs for efficiency measures (Lucon et al. 2014, OECD/IEA 2014). For the building sector, only monetary co-benefits are at least twice the resulting operating cost savings (GEA 2012 cited by Lucon et al. 2014). The IPCC report agrees highly and has found robust evidence that there are a number of significant non-monetary benefits and that "these benefits offer attractive entry points for action into policy-making, even in countries or jurisdictions where financial resources for mitigation are limited (high agreement, robust evidence)". (Lucon et al. 2014).

The multiple benefits approach can suggest ways to overcome the inactivity in building renovation. It poses the question which actors – besides the owners of buildings – should pursue energy-efficiency measures and what could be their motivation to do so.

Because the multiple benefit approach is rather new, only few studies have been conducted in the buildings sector to understand who benefits and to which extent they benefit. A closer look on the municipal perspective was taken by Weiß et al. (2014), who intended to quantify the municipal welfare and employment effects for energy renovations in Germany.

Responding to the call for municipal action, this paper aims to analyze possible economic benefits for municipalities to encourage them to push forward energy-efficiency renovation through information campaigns and/or diverse investment programs. As the municipal government is closest to the people, local politicians play a vital role in educating, mobilizing and responding to the issues that promote energy renovations (Barrutia and Echebarria 2013). Following the arguments of Ostrom (2010), considering the numerous positive side effects of energy renovation, municipalities should recognize that they have the possibility and many reasons to choose a low carbon urban buildings future. By guiding and accompanying their citizens through the renovation process, they have the ability to reach an optimal municipal net-efficiency. Moreover, through the integrated planning of urban development, the municipality has the chance to effectively address problems as gentrification and energy poverty.

This paper is therefore a first attempt to quantify the multiple benefits of building energy efficiency from the perspective of a municipality. It poses the following questions:

- What reasonable renovation scenarios are available for a city or municipality?
- What is the size of the economic effects when these scenarios are implemented?

This paper also aims to contextualize the multiple effects of an energy transition from a municipal perspective. In the empirical part of the paper the following questions are posed:

- What effects are important for the municipal government?
- Are the net effects, from the perspective of the municipal government, of positive or negative nature?
- Who should finance the energy measures?
- Who is responsible for the energy transition?

By using the city of Delitzsch (Saxony) as an illustrative case study, this paper evaluates the macro-economic impacts of energy-related renovation measures for shrinking and aging middle-size municipalities in Germany. The analysis is divided into three parts and is based on the authors' previous work (see Gröger 2014, Verhoog 2013): Firstly, renovation scenarios distinguish between the behavior of landlords and that of home owners. Landlords tend to take into account the techno-economic optimization potential for renovations, while home owners decisions on refurbishment are more likely influenced by socio-economical parameters, which are derived from lifestyle-data. Secondly, the scenario effects on the municipality are evaluated. Factors such as municipal tax revenues, local employment effects, avoided energy imports as well as the ecological impact are analyzed. The investment and ecological effects of energy-related refurbishment are determined through the integrated scenario-based energy modeling tool DESCoM (Gröger 2013); while welfare effects are estimated on the basis of literature research. The third part summarizes the results of a qualitative survey among mayors of municipalities with decreasing and aging population in Saxony on their perception of benefits from an energy transition towards a low carbon system.

Local benefits of energy efficiency

Much research has been carried out to understand how and why municipalities engage in climate change mitigation. The literature can be divided into two directions. One strand of literature focuses on the motivation and barriers for municipal climate change mitigation mostly from a descriptive policy perspective (see Azevedo et al. 2013, Kousky and Schneider 2003, Betsill and

Bulkeley 2007, Sippel and Jenssen 2009). The second strand of analysis takes the (co-)benefits, adverse side effects and externalities into focus and it usually employs an economic perspective (see for a review: Lucon et al. 2014, OECD/IEA 2014). For this paper, the literature is summarized in table 1 which lists important effects on different municipal stakeholders. The table considers only additional effects of mitigation measures of energy efficiency measures in buildings. Climate change mitigation effects which are not stakeholder specific are not considered, as e.g. reduction of heat waves and less natural catastrophes.

Research for Germany (Projekt 100 %-Erneuerbare-Energie-Regionen 2009), the United States and Canada (Kousky and Schneider 2003) revealed that reductions in the dependence on fossil fuels (i.e. an increasing energy security), the regional welfare effects (positive labor effects, higher tax revenues) and enhancement of regional development are the most important motivations for municipal climate mitigation measures. Climate change goals range only at the fourth position. With this reasoning, this analysis focuses only on the local economic effects of energy-efficiency measures in the buildings sector.

LOCAL ECONOMIC EFFECTS FROM BUILDINGS EFFICIENCY

Local economic effects can be divided into short term and long term effects. Short term effects relate mainly to welfare effects such as energy cost savings, tax revenues, profits, growth and job creation. Long term effects comprise e.g. alleviation of fuel poverty and therefore social aid money reductions, reduced social aid expenses due to better air quality etc. as well as to the increased value of the local building stock. Other economic co-benefits on the local level are the increased diversification of energy sources and reduced illnesses associated with room temperature which lead to reduced medical expenses and reduced loss of income due to unpaid sick leave from work and school (Lucon et al. 2014). The effects can, besides short term and long term effects, be divided according to their beneficiaries. Table 2 illustrates that multiple economic effects are created on a municipal and building owner's level.

The effects on tenants are not considered since they hardly have the possibility to initiate energy efficiency refurbishments.

The case of a German shrinking and aging middle size city

Germany intends to change the overall energy system and has set ambitious targets such as the reduction of greenhouse gas emissions by at least 80 % by 2050 (against 1990 levels) and the shutdown of all nuclear power plants. In addition it is foreseen to reach a 50 % reduction of primary energy consumption (compared to 2008) by 2050 and a reduction of 80 % of buildings primary energy demand (BMWi and BMU 2012). Several politicians and researchers have recognized the relevance of German municipalities arguing that these would play a central role in implementing the energy transition and are even responsible for the success or failure of this system transformation (see e.g. Nestle 2012, Kreft et al. 2010, Scholl 2012, Schönberger 2013).

The case study focuses on heavily shrinking middle-size cities since they are confronted by the urgent need to innovate. Nevertheless, they may acknowledge the necessity to implement a transformative project such as the energy transition, but they may not have the means. Rapidly shrinking cities with aging population are clustered by the Bertelsmann Foundation as "type 9" communities (Große Starmann and Klug 2012). According to this study in Germany, there are 264 municipalities of this type mostly located in Eastern Germany, particularly in the German Bundesland of Saxony, of which 40 % fall into the group of middle-size cities with 10,000 to 25,000 inhabitants. The most obvi-

Table 1. Direct specific effects of energy refurbishment on involved stakeholders.

Involved stakeholder		**Home owner/tenant**	**Municipal government**	**National government**
Direct specific effects	**Economic effects**	Cost savings Increased Building value Higher rents	Local tax effects Local income effects Local job effect Energy independence More local expertise	Net welfare effects Net growth Net job effects Energy security Energy independence Innovation/technological leader/competitiveness Reduced medical expenses Reduced social aid expenses
	Ecologic effects		Air quality	Resource maintenance
	Social Effects	Better health Increased heat comfort Higher visual comfort Better acoustic comfort Increased indoor air quality	Less energy poverty Little acceptance More gentrification Better design and urban quality	Little acceptance
	Other effects		Higher reputation/image/political champion/role model	Reputation/image

Source: own elaboration, based on IPCC, Sippel and Jenssen 2009, BMUB 2014.2 lines, Height: 17 mm

Table 2. Economic effects of energy renovation on stakeholders.

	Municipal Government Perspective	Building Owners Perspective	
		Landlords/Companies	Home owners
Short Term Effect	Net employment impact Net welfare Effects	Net cost effects	Net cost effects
Long Term Effect	More innovation Higher degree of energy independence Positive location factor New expertise Reduced social aid money	Increased competitiveness Increased productivity Increased asset value/ Attractive building stock	Increased asset value Higher energy independence

Source: own elaboration.

Table 3. Comparison of demographic characteristics.

Indicator	City of Delitzsch	All type 9 communities	German average
Demographic Development 2001–2008 (%)	-6.30	-9.09	-0.83
Share of 65–79 years old (%)	17.7	19.7	15.6
Share of one-person-households (%)	37.7	38.0	34.3
Purchasing power (Average in Euro)	35,797	31,570	42,892

Source: Bertelsmann 2014.

ous problem of type 9 communities is the significant outflow of residents and that those who have chosen to stay are of advanced age and have lower income than the average. Characteristically, these municipalities suffer from a low purchasing power of the local population related to income poverty, huge budget deficits in the public sector and a low level of human capital.

THE CITY OF DELITZSCH

The city of Delitzsch covers a surface area of 83.57 km^2 and has 25,361 inhabitants (as at 9 May 2011). It has five city districts (Center, Northeast, Northwest, Southeast and Southwest) and includes 14 sub-urban districts. Although the city has an urban character, the suburban districts have a rather rural character. The city connotes demography and buildings related indicators of rapidly shrinking, middle-sized cities. Table 3 summarizes basic demographic characteristics of the city of Delitzsch, and compares it with the average of all type 9 communities and the overall German average:

The population in Delitzsch decreased from 2001 to 2008 by 6.3 %. It is predicted that the population will further decrease by 15.5 % from 2009 to 2030. This trend is even stronger for all type 9 communities (base year: 2011; Große Starmann and Klug 2012). In Delitzsch, as well as in all middle size type 9 municipalities, the share of buildings that were erected before 1919 and between 1919 and 1948 is considerable larger than the average German building stock (Stadt Delitzsch 2009, Diefenbach and Loga 2011, Census 2011, see Figure 1).

Even though the year categories of the Census-dataset, source of the data for type 9 municipalities, differ by up to two years from the IWU typology, the very different buildings structure in the municipalities becomes clear.

These large portions of old buildings can make the issue of energy-efficient refurbishment even more serious because buildings of high age are characterized by low energy performance. At least as long no renovation is carried out after construction. Figure 2 assesses the demand of useful energy according to the construction year once with renovation cycle and once without. While two energy renovation scenarios are possible, it is most likely that the real useful energy demand lies in between.

Only after the implementation of the first Heat Insulation Ordinance (*Erste Wärmeschutzverordnung*) in 1977 in Germany, which aimed to promote better insulation standard for buildings, energy demand in new buildings has decreased considerably. In the former German Democratic Republic (GDR) – where Delitzsch is located – a comparable insulation standard, the TGL 28706 (*TGL – Technische Normen, Gütevorschriften und Lieferbedingungen)* regulation was implemented in 1982 (Weglage 2008). From this year the energetic standard of buildings can be determined according to the ordinances. The useful energy demand of buildings (in kwh/m^2*year) for the two scenarios is illustrated in Figure 2.

For the case study in the City of Delitzsch we assume the scenario with the renovation cycle (RC). As after the reunification of Germany almost all buildings in the former GDR were renovated, although an energetic renovation was not focused. In the light of the research question of this paper this was assumed the most conservative scenario.

Approach and methodology

This research aims to estimate short term economic-effects on the municipality, including municipal tax revenues, local employment effects, avoided energy imports as well as the ecological impact. The calculation of avoided energy imports, the ecological impact as well as the expected investments are based on the model DESCoM. The estimation of tax revenues and local employment effects are derived from the expected investments. The parameters that were necessary for doing so were identified through a literature research.

This research builds on a geo-referenced database for the city of Delitzsch. The data set comprises:

1. The complete building stock of the city of Delitzsch with information on the respective building (construction year and house type) and its square meters, and;
2. Geo-referenced lifestyle data. The database connects inhabitants with a specific life-style membership to a specific building and hence describes where lifestyle groups are located in the city. The lifestyle data used are the Sinus Milieus® a model classifying people according to their attitudes to life and ways of living.

The investment effect, the avoided energy imports as well as the avoided greenhouse gas emissions are determined through the integrated scenario-based energy modeling tool *Decentralized Energy Supply Conception Model* (DESCoM). This model was developed at the Chair of Energy Management and Sustainability of the University of Leipzig to assess energy-efficiency measures that pertain to tradeoffs between cost and emission reductions (Gröger et al. 2013, Gröger et al. 2014). For this paper, the model investigates the effect of a total renovation (walls, roofs, upper floor ceilings, basements, windows and entrance door) within the framework of the German Regulation for Energy Saving in Buildings (Energieeinsparverordnung EnEV 2014) and calculates the above mentioned effects of energy-related renovation for every individual building in the city.

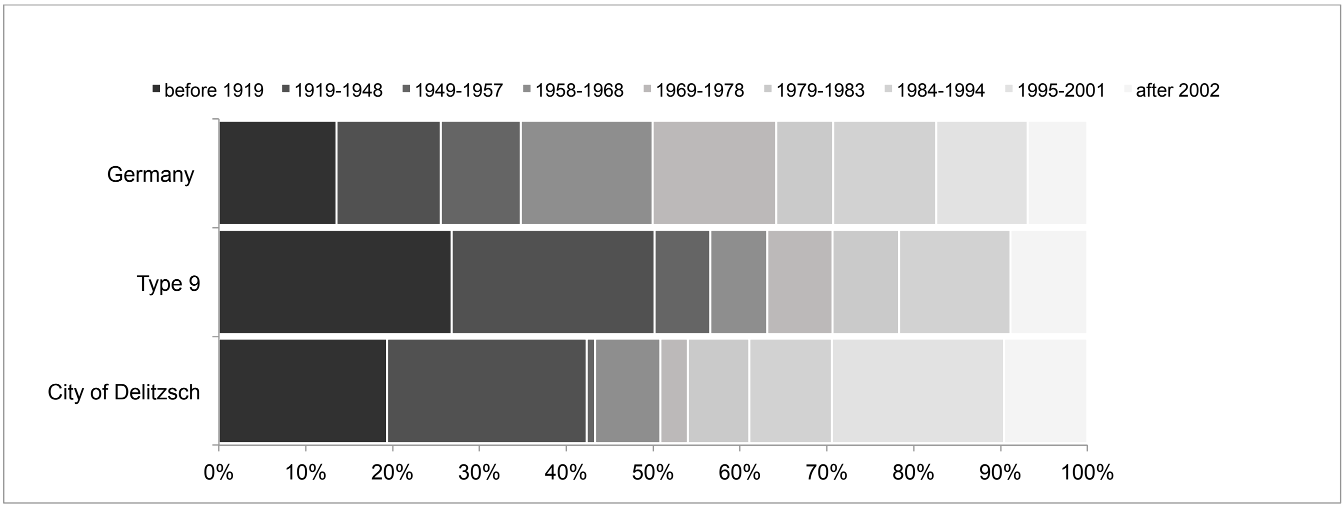

Figure 1. Share of building stock according to construction year in the City of Delitzsch, all type 9 municipalities (with 10,000 to 25,000 inhabitants) and in Germany (own elaboration; based on Stadt Delitzsch, 2012, Diefenbach and Loga 2011, Bertelsmann 2014, Census, 2011, own calculations).

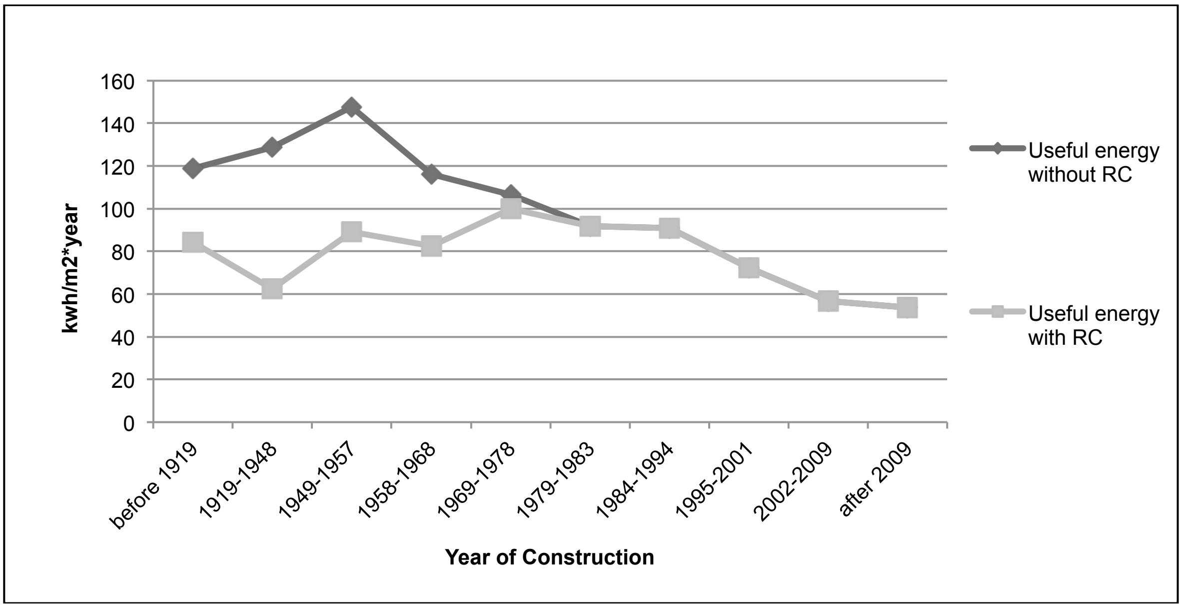

*Figure 2. Useful energy of buildings according to construction year in kwh/m²*year (own elaboration based on own calculations with DESCoM).*

The detailed, bottom-up physical modeling approach consistently considers interdependencies between the execution of retrofits and the functioning of energy supply technologies. The model reflects the diverse building typology of the German residential building stock and illustrates their characteristics in relation to the energy demand. The implemented buildings represent a detailed and disaggregated image of the German building stock when considering building types. The typology approach used in this paper was established by the Institute for Housing and Environment (IWU) and consists of a classification scheme (Loga 2012). The modeled energy demand is essentially based on building physics and the respective thermal behavior of buildings in relation to their environment. Being aware that behavioral aspects such as indoor temperature level or ventilation habits are an important influence factor of the energy demand, the energy balance according to applicable German DIN standards has been supplemented by the residents' user behavior.

In addition to the energy demand and related emissions, the model calculates annual full cost for each building and efficiency measure. The economic evaluation includes cost of insulation measures as well as the levelized cost of energy of the considered heating technology based on investment related costs, operation and maintenance costs and fuel costs.

The database comprises 5,150 buildings, divided in single and multifamily houses. Since there is no information on the ownership of the individual buildings, the buildings in the database were randomly assigned to be inhabited by tenants or home owners. Hereby, up to 85 % of single family houses are assumed to be inhabited by home owners and up to 15 % by tenants. In addition, 15 % of multifamily houses are inhabited by their owners and up to 85 % are rented out. The distribution of home owners and landlord in these buildings is depicted in table 4.

Instead of assuming that a certain increase in energy renovation is randomly distributed to the cities building stock, this paper aims to build real-world scenarios. It does so by applying rational and non-rational decision making rules. The latter are referring to those decisions that are based on bounded rationality (Wittmann 2008). Through the development of these two scenarios, the dimension of the positive effects for the municipality can be predicted. Each scenario considers the behavior of landlords and home owners in combination with building type (single family houses or multifamily houses) in a sophisticated manner.

The first scenario is the "base"-scenario. It describes a world with an annual renovation rate of approx. 1 % without any form of intervention at the municipal level. Interventions in this context can be interpreted as measures that motivate home owners to refurbish as promotional activities for refurbishment, like informational events, energy consultancy or municipal financial support in the case of refurbishment activity. The second scenario is an "intervention"-scenario, which applies these kinds of promotional activities for refurbishment at a municipal level. As a consequence, the renovation rate in this scenario is accruing up to approx. 3 %/year.

The scenarios distinguish between two decision rationalities depending on ownership and building type:

Landlords take into account the techno-economic optimization potential for renovations (Verhoog et al. 2014). The decision rule applied for these actors can best be described as rational, as in the "base"-scenario landlords are only willing to refurbish when this activity is profitable. In the "intervention"-scenario landlords softened this criterion a bit and are willing to invest in refurbishment up until a level of aggregated cost savings that yields up to 10 % below investment costs. In other words, landlords are willing to take a loss up to 10 % of investment costs in this scenario. This decision rule is applied on both single and multi-family houses, as soon as landlords are involved. The economic feasibility and the profitability are derived through the modeling data of DESCoM.

Decisions of homeowners are influenced by socio-economical parameters. The non-rational decision rule is derived from specific lifestyle-research. Verhoog et al. (2013) show a clear linkage between lifestyles and refurbishment disposition. Therefore, in the scenario the decision for energy-efficiency renovation is linked to the existence of certain lifestyles in the city: Homeowners with the highest disposition to refurbish (22.4 % of the lifestyle group called the "adaptive-pragmatics" confirm their intent to refurbish in the survey context), do refurbish without interventions in the "base"-scenario. The "adaptive pragmatics" make up 5.4 % of the population in the city. In the "intervention"-scenario, also those with slightly lower disposition to refurbish (18.4 % of the lifestyle group called the "performers" confirm their intent to refurbish in the survey context) finally decide to renovate as well. The "performers" make up 6.1 % of the population in the city. This decision rule is applied for single family houses only. As soon as homeowners reside in multifamily houses, the refurbishment decision making is influenced, or more precisely obstructed, by group decision making processes in the condominium owners' meeting. It is assumed that group decision making in these events leads to a more strict application of profitability criteria. Hence the profitability criterion of landlords was applied for homeowners in multi-family houses. Table 5 summarizes the assumed decision rationalities to undertake an energy refurbishment.

As discussed earlier, the "intervention"-scenario has a cost side too. In the "intervention" scenario, costs amounting to €200,000

Table 4. Number of buildings in the different categories.

	Single Family House	Multi Family House	Total
Homeowner	3,123	221	3,344
Landlord/Company	551	1,255	1,806
Total	3,674	1,476	5,150

Source: own elaboration.

Table 5. Applied Decision Rationality.

	Single Family House		Multi Family House	
	Home Owner	**Rented/Company**	**Home Owner**	**Rented/Company**
Base Scenario	Only the adaptive pragmatic-milieu invests	Investment decision based on economic feasibility	Investment decision based on economic feasibility (-10 %)	Investment decision based on economic feasibility (-10 %)
Intervention Scenario	The adaptive pragmatic and the performer milieu invest	Investment decision based on economic feasibility	Investment decision based on economic feasibility (-10 %)	Investment decision based on economic feasibility (-10 %)

Source: own elaboration.

Table 6. Scenario effects and local value creation.

	Final Energy Reduction (MWh)	CO_2 Emission Reduction (ton)	Investments (Mio. Euro)	Job-years created	Municipal Tax Revenues (Euro)
"Base"-scenario	26,110	6,561	5.18	65	103,510
"Intervention"-scenario	51,392	13,053	15.58	195	211,509
Intervention-effects	25,281	6,492	10.40	130	208,000
Local effects (70 % of Intervention-effects)			7.28	91	145,600

Source: own calculations.

are assumed to accrue for the City of Delitzsch, caused half by labor cost and half by non-labor costs (events). All results of the scenario simulations are discussed in the next section.

To quantify the expected labor effects, a literature research was carried out. For energy-efficiency renovation the effect is calculated to create 12 to 13 net job-years per million Euros spent in 2011 in Germany (Diefenbach et al. 2012, Weiß et al. 2014). The effect is comparable to the international average of 13 job-years per million USD spent (Lucon et al. 2014).

Similar to the employment effect, the municipal tax revenues are derived from literature findings for Germany. It ranges from 18,400 Euro to 20,750 for each 1 Mio. Euro spent (Weiß et al. 2014, Kuckshinrichts et al. 2012).

The full extent of economic benefits of mitigation efforts can only unfold at the local level, when local structures exist to meet the subsequent demand for refurbishment services and products. With lacking local economic structures, refurbishment suppliers from nearby and surrounding cities will most likely jump in resulting to diminishing local effects. A major question concerning the assessment of economic benefits of mitigation efforts pertains therefore to the degree of the availability of services of local skilled craftsmen. Research in this specific area is rudimentary; however, revealing so much, that for small cities with less than 100,000 inhabitants, it may be assumed that skilled craftsmen are locally present "for the larger part" (Weiß et al. 2014). Based on this research, a conservative portion of 70 % was set for local value creation.

On the basis of the aforementioned database, modeling activities, scenario building and literature research the effects for the city of Delitzsch are determined.

This desk research approach is complemented by primary research through semi-structured expert interviews. Eight municipalities with similar preconditions to the case study were selected to understand, if mayors, as representatives of municipalities, have present the multiple benefits of mitigation activities. It is argued, that only if this is the case the positive effects can unfold their impact on mitigation activities.

The interviews are a result of a master thesis that focused on mayor's perception of possible threats and benefits through the energy transition in municipalities and cities (Bergmann 2014). All interviewed cities are in the Federal State of Saxony. The inhabitants of the cities range between 18,000 and 30,000 inhabitants. All of them are so called "type 9" communities. Interviews were carried out both by physical meetings (5) and by telephone (4). The applied guideline questionnaire comprised 30 open questions related to motivations, barriers and actions of the municipality to implement climate change mitigation policies. The responses were not predefined; consequently, the experts decided themselves about the answers' comprehensiveness. One bias was identified: the interviews had a broader focus than this paper applies. Nevertheless, the interviews can provide an insight into the mayors' reasoning concerning the local economic impact of an energy transition.

Results of the scenario analysis

As discussed before, this paper assumes that a portion of 70 % for local value creation is realistic. This share builds the basis for the results shown in Table 6.

Even after the incorporation of a portion of 30 % of value creation is not realized locally, the tangible economic benefits are still notable. The first benefits discussed, energy reduction, can be best assigned to home owners and tenants. The benefits of reduced CO_2 emissions must however be assigned to the society at large. Furthermore, the benefits of investments caused by refurbishment activity can best be attributed to the local economy through job creation. In addition, the benefits of the generation of municipal tax revenues can be assigned to the local economy as well.

Firstly, a final energy reduction of 25,281 MWh is reached for 200 building owners, which leads to an average energy cost saving of approx. €300 per year for every individual homeowner for 25 years.[1] In the normal case, an owner will (mentally) offset his refurbishment investment costs by this energy saving.

Secondly, the reduction of CO_2 emissions thanks to the refurbishment amounts to 6,492 ton (or 32.5 ton per building). The "value" or financial equivalent of these emissions can be expressed in terms of CO_2 emission certificates. Despite the current low market value of these emission rights (approx. €7 per ton of CO_2 emissions per year), the financial equivalent still would yield up to €228 per year per owner, if the building sector's emissions would be part of the European emission trading scheme.

Thirdly, the refurbishment activities caused by the "interventions" scenario lead to local investments of €7.28 million. These investments initiate the creation of jobs and municipal tax revenues. With the literature suggestion that per €1 million local investment creates 12 to 13 jobs in Germany, the aforementioned sum creates 91 job-years locally. On top of that, literature suggests that the local tax revenues amount to €18,400 to €20,750 for each €1 million spend. As a result, tax revenues to the amount of €145,600 are created in the "intervention"-scenario. As discussed earlier, the "intervention" scenario however costs a minimum of €200,000. As a whole, the simulation shows that from a narrow financial perspective the "intervention" scenario can be financed for the larger part through the benefits that were created in the "intervention"-scenario.

Results of the interviews

The municipality is a large energy consumer, planning authority, regulator, property owner and often owner or associate of public utilities, manager and consultant. Local mitigation policy is predominately a top-down decision (Kousky and Schneider 2009). A review of research on municipal mitigation activities revealed that a committed leadership from the political sphere can significantly influence the level of local involvement and can provide an impetus for local climate governance. Some studies even go further and state that "without a strong support from the decision makers, climate change will not be on the local government agenda" (Sippel and Jenssen 2009). As this role can be taken by the mayor (Schubert 2011, Kreft et al. 2010) this research focuses on mayors' perception of positive and negative effects of mitigation policies. All interview results are taken from a master thesis research (Bergmann 2014).

The qualitative survey approach of this research aims to assess the importance and the perception of multiple benefits from a mayors' perspective. It poses the following questions:

- What effects are important for the municipal government?
- Are the net effects, from the perspective of the municipal government, of positive or negative nature?
- Who should finance the energy measures?
- Who is responsible for the energy transition?

In the following sections the results of the interviews to these questions are summarized.

WHAT EFFECTS ARE IMPORTANT FOR THE MUNICIPAL GOVERNMENT?

Economic benefits are central for the implementation of energy transition activities. Measures that are not economically feasible and connected to financial benefits will not be carried out. Climate protection as the only rationale for doing so is not enough. This is confirmed by all nine interview partners. The opportunity to reduce costs by consuming cheap energy is seen as the central benefit for the local economy. Especially the advantages of a decentralized energy supply that leads to reduced energy imports from international, insecure non-renewable sources is recognized as important energy transition impact by four mayors. Tax revenues, new job creations and the cities attractiveness for new companies, citizens and investors are some possible outcomes that are interesting for the mayors as well.

Nearly all the interviewed mayors agree that the engagement for the energy transition might be beneficial to their political reputation. Remarkably, three of five cities that were severely hit by high floods mention that these natural disasters triggered a rethinking about climate mitigation and adaptation.

Nevertheless adverse side effects predominate the mayors' perception of the energy transition. Seven of the interviewed mayors worry about the tremendous costs of the energy system change in terms of rising energy prices, investment costs, R&D expenditures and financial support for deprived citizens. Five mayors are also very skeptical about the provision of the basic power supply by renewable sources and doubt the feasibility of a complete change towards renewables. Rising energy costs were also mentioned for the municipal level. The current energy cost increases hit the municipality significantly and they try to compensate as much as possible to prevent to pass it on to their citizens. All energy-saving measures are thereby diminished, because with rising costs, the expenses stay the same or even increase.

The results regarding the perceived effects of a local energy transition and the perception of the effects direction are summarized in table 7.

WHO SHOULD FINANCE THE ENERGY MEASURES?

Almost none of the nine cities are interested in directly supporting the energy transition activities of their citizens through loans and grants. Only one city experimented with a specific funding program for the construction of low energy houses to attract young families. Either because most of the renewable energy measures were anyway installed by private persons and they do not see additional demand or because the mayors think that everyone has to take care of their own business: if individuals or companies are convinced of the usefulness of energy transition measures, they should also pay for it out of their own pocket and take over the implementation responsibility. In their point of view, a huge effort has to be done to reach the citizens and change their behavior. Anyhow, this would only

1. This saving is based on the most frequent energy carrier in the City of Delitzsch, gas, with costs of €0.06 per kWh. This saving calculation is conservative as it does not take future price increases into account.

Table 7. Perceived economic effects of a local energy transition and their perception.

Perceived Effects	Perception of net effect by mayors
Financial support for deprived citizens	Negative
Investment costs	Negative
Energy costs	Mostly negative
Reduce import dependency	Positive
Tax revenues	Positive
New job creation	Positive
Cities attractiveness for new citizens, companies and new investors	Positive
Political Reputation	Positive
Energy security	Negative

Source: own illustration.

be possible through financial benefits or pressure from the authorities. Voluntarily, according to their view nobody would care for climate protection measures.

WHO IS RESPONSIBLE FOR THE ENERGY TRANSITION?

A long-term vision in regard to the energy transition process for a stable planning is desired from the Federal Government. Mayors see municipalities not as central player in climate protection and the energy transition. At first front, the Federal Government and the Federal States would need to act. It would be their duty to engage in climate protection measures and to create a political environment conductive to offer best conditions for their municipalities. Related to the incentives are the regulations: five of the interviewed mayors admitted they would be willing to engage for the energy transition if it was a compulsory task but as long as it remains voluntary, they would focus on other duties.

Summary

The scenario analysis in the modeling part of this paper shows that the interventions scenario would cost the municipalities €200,000. Apart from other benefits it leads to additional 7.28 Mio. Euro investments in energy-efficiency measures. This creates locally 91 additional job-years and increases the income of the municipal household by 145,600 Euro through tax revenues.

Summing up the mayors' statements regarding the cities' future development and attitudes towards the energy transition, it can be concluded that without additional external incentives, regulatory actions or restrictions, the municipalities will continue with the business as usual which corresponds to the base scenario. Mayors face central problems as aging, shrinking, migration, unemployment and non-existent infrastructure. The energy transition is perceived as an additional challenge and not as a solution by most of the interviewed mayors. The citizens' quality of life is regarded as very relevant by all the mayors and therefore social aspects of the energy transition could motivate the mayors to take up measures. These refer to stable energy prices to avoid energy poverty, high housing standards and vast recreational facilities. Clean air and water, little traffic and a beautiful surrounding landscape count as environmental indicators that the mayors are concerned of. The political field is after economic reasons the second important motivation basis. A particular emphasis is placed on the higher level authorities (EU, Federal Government, State) that could externally motivate the mayors through regulatory pressure, enabling schemes and grants as well as legislative decision-making to set energy transition measures as compulsory task.

Discussion

This research shows that besides other effects, considerable economic effects can be expected if municipalities are able to trigger renovation activities in their communities. Type 9 communities, who see themselves confronted with major obstacles in the future, could reach some of their core goals such as local job creation and balancing of municipal budgets by taking part in the energy transition. It focuses in the interview part on the perceived benefits by central actors. The results indicate that multiple benefits from energy efficiency are not perceived as such. Mayors name the benefits but do not apply them to their context.

Nevertheless, it can be concluded from the interviews that mayors confront many urgent issues in their municipalities and do not have the resources to take the path into an energy-efficient future. Without additional external incentives, regulatory actions or restrictions, the municipalities will most likely continue with business as usual. Mayors face central problems such as aging and shrinking population, migration, unemployment and issues related to infrastructure. The energy transition is perceived merely as an additional challenge and not as a solution by most of the interviewed mayors. Here, other beneficiaries of an energy transition might need to jump in to make a local energy transition happen.

This paper poses in the modeling part a new case study based approach to quantify municipal co-benefits. It complements existing literature (Weiß et al. 2014) by taking into account every individual building and its corresponding building type. In this way it is much more detailed as the existing literature. A novel approach for the development of scenarios is to take into account lifestyle data. This approach is based on literature findings that suggest that home owners are non-rational decision makers. Using geo-referenced lifestyle data that is otherwise mainly applied in marketing allows the assumption of future renovation activities of home owners. A shortfall is that the techno-economic reasoning for single family houses was not fully addressed. The reason for this was that the calculated full renovation was not economically feasible in single-family houses. This research can be improved by applying partial renovation scenarios.

The results aim to enrich the discussion on multiple benefits, co-effects and adverse side effects on a local level. Relevant stakeholders can be confronted with the results of the scenario approach to visualize the positive outcomes of moving towards energy efficiency. Results can be used in this way as argumentation to convince central actors and to ease difficult political decision-making. Especially in type 9 communities, where mayors confront major problems besides the energy efficiency of buildings these results can make decision makers rethink their strategies and rather see energy efficiency as an opportunity than as a challenge.

The multiple benefits approach can only unfold its strength on a local level if concrete stakeholder related benefits can be named and quantified. By this central stakeholders can get motivated to strive for more energy efficiency in buildings. Their participation will make it easier to reach the goal of 80 % primary energy reduction in the buildings sector by 2050.

Glossary

RC	Renovation Cycle
GDR	German Democratic Republic

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