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Scaling-up energy conservation initiatives: Barriers and local strategies

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ABSTRACT

Energy conservation in residential and commercial buildings is considered a key challenge and opportunity for low-carbon urban development. In cities worldwide, energy conservation initiatives have been realized that demonstrate the social, financial, and environmental benefits that energy conservation can generate. However, in order to accomplish international goals pertaining to climate mitigation, these initiatives need to go to scale and reach a greater and broader audience. To accelerate the scaling-up of such initiatives, an in-depth understanding of barriers hampering this process and local strategies that can be applied to address these barriers is required. While scholars and practitioners underline the importance of local solutions to the global problem of climate change, little is known about strategies that can be applied at the local level to overcome barriers. This paper has three general findings that can make a valuable contribution to theory and practice on urban climate governance. First, it sketches the context-specificity of barriers to scaling-up energy conservation initiatives and reflects on similarities and differences in barriers to energy conservation in residential and commercial building stocks in two European cities: Utrecht and Valencia. Second, this paper presents several local strategies that can be applied to overcome barriers, thereby improving our understanding of the relation between barriers and solutions. Finally, the findings of the paper suggest that while many barriers have national or international origins, the local environment appears to be a promising scale to address barriers.

1. Introduction

The retrofitting of residential and commercial buildings is considered a key challenge and opportunity for low-carbon urban development (Immendoerfer, Winkelmann, & Stelzer, 2014; Levine et al., 2007). In Europe, the building stock is the greatest contributor to carbon emissions and contributes to approximately 40% of final energy consumption (Pérez-Lombard, Ortiz, & Pout, 2008; UNEP, 2009). Energy conservation is seen as the fastest and most cost-effective way to mitigate climate change and reduce global greenhouse gas emissions (GHG) (Levine et al., 2007). Energy conservation initiatives (henceforth 'EIs' or 'initiatives') in the existing building stock – focused on the implementation of technological or behavioural energy conservation measures to reduce energy consumption and abate GHG emissions – are regarded effective means to accelerate the transition to low-carbon cities. In addition to their climate mitigation impacts, EIs are associated with various co-benefits, including job creation, business opportunities, and increased comfort, health, and quality of life of citizens (Boardman, 2010; Immendoerfer et al., 2014; Levine et al., 2007; UNEP, 2009).

In European cities, EIs have been realized that demonstrate the financial, social, and environmental benefits of energy conservation. Previous studies have reflected on success factors to the realization of such initiatives and indicate that successful initiatives are often initiated by actors who are intrinsically motivated to engage in the process due to their levels of environmental concern and willingness to pioneer (Chmutina, Wiersma, Goodier, & Devine-Wright, 2014; Klein Woolthuis, Hooimeijer, Bossink, Mulder &

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Brouwer, 2013; Seyfang, 2010; van Doren, Driessen, Runhaar, & Giezen, 2016). However, what are barriers to the increase in uptake, spatial growth, and replication – i.e., the scaling-up (van Doren et al., 2016; World Bank, 2003) – of such EIs? And what strategies can initiators of EIs and other actors with an interest in the scaling-up of EIs apply in order to address these barriers? In order to develop effective urban governance arrangements for accelerating the low-carbon transition, we need to develop an integrative understanding of barriers to scaling-up and local strategies that can address these barriers. First, an accurate diagnosis of the diversity of barriers hampering the scaling-up of EIs is required. Studies often emphasize different barriers, and there is a need to combine these various perspectives in order to obtain an integrative overview of the full spectrum of barriers that need to be addressed. Moreover, while studies suggest that barriers to energy conservation are context-specific and interconnected, there is a need to further enhance our understanding of these issues (Fleiter, Schleich, & Ravivanpong, 2012; Kranzl et al., 2014; Stieß and Dunkelberg, 2013; Trianni and Cagno, 2012). Second, local strategies need to be identified that can address the different barriers. A focus on the local level is deemed justified because cities, municipalities, and urban regions worldwide have expressed their interest in promoting low-carbon urban development, demonstrating that the local context is an appropriate scale at which strategies to address barriers will be put into action (Betsill and Bulkeley, 2006; Burch, 2010; Schreurs, 2008; Selman, 1998). However, due to the relatively immaturity and lack of institutionalization of the field of urban climate governance (Anguelovski and Carmin, 2011), there is still limited knowledge on strategies that public and private actors can apply to further the low-carbon transition. Previous studies have focused primarily on strategies that can be applied at the international and national level by state actors (Baek and Park, 2012; Kranzl et al., 2014; Tuominen, Klobut, Tolman, Adjei, & de Best-Waldhober, 2012) and scholars stress the need for a greater understanding of how local strategies can contribute to mitigating the global problem of climate change (Anguelovski and Carmin, 2011; Burch, 2010; Rutherford & Jaglin, 2015).

This paper aims to contribute to theory and practice on urban climate governance by diagnosing the nature of, and relations between, barriers to scaling-up EIs and by exploring local strategies that can address these barriers. While EIs are realized in different types of buildings, the focus of analysis will lie on scaling-up initiatives in residential and commercial buildings, because these two building stocks are jointly accountable for the major share of energy consumption (UNEP, 2009). A comparative analysis is conducted of two European cities, Utrecht and Valencia, in which the local governments aim to accelerate low-carbon urban development and various EIs have already been realized (Municipality of Valencia, 2014; Municipality of Utrecht, 2011). The variation in terms of socio-cultural, market, policy, and built and geographical context allows us to explore the context-specificity of barriers and general conditions required for scaling-up.

The paper will proceed with an introduction to our analytical framework. Section 3 will elaborate on the method applied. Subsequently, section 4 will present the results of our analysis, followed by a comparative analysis and reflection on the findings in section 5.

2. Analytical framework

2.1. Barriers to scaling-up energy conservation initiatives in the existing building stock

Energy conservation initiatives refer to initiatives where energy conservation measures (ECMs) are applied. Examples include the retrofitting of streets or neighbourhoods, housing blocks, or business districts. There is an extensive array of technological and behavioural ECMs that can be applied to reduce energy consumption and abate GHG emissions in existing buildings. Measures to save energy can relate to, amongst others, the building's thermal envelope, heating system, HVAC, energy management, lightning, water management, appliances and electronics, and occupant behaviour (Abdellatif & Al-Shamma'a, 2015; Levine et al., 2007). In addition to climate mitigation, EIs can also generate co-benefits such as improvement in health, productivity, comfort, and local employment (Boardman, 2010; Immendoerfer et al., 2014; Levine et al., 2007; UNEP, 2009). While the retrofitting of existing buildings – through EIs – has the potential to reduce Europe's building sector's emissions with 30–36% by 2030, there is a need to accelerate the scaling-up of EIs in order to reach this potential and accomplish international and European climate mitigation goals (Energy Efficiency Financial Institutions Group (EEFIG), 2014; International Energy Agency (IEA), 2013; Levine et al., 2007; UNEP, 2009).

While the concept of scaling-up can encompass various meanings, we interpret it as a process where there is an increase in uptake, growth, or replication of EIs ('horizontal pathways to upscaling', see World Bank, 2003; van Doren et al., 2016). At present, EIs are primarily realized by actors who are driven by environmental concern and a willingness to demonstrate that 'it can be done' (Chmutina et al., 2014; Klein Woolthuis et al., 2013; Seyfang, 2010; van Doren et al., 2016). However, to accomplish the low-carbon transition, such initiatives need to be scaled-up beyond green-minded actors and reach a wider public. Yet, the widespread scaling-up of EIs remains a challenge due to various barriers to energy conservation that the wider public, such as households and enterprises, are confronted with. An adequate assessment of barriers experienced by this group is required to deepen the knowledge base on conditions that need to be addressed to accelerate the scaling-up of EIs. We define barriers to scaling-up EIs as any condition or factor that impedes households, enterprises, or other demand-side actors from initiating, engaging in, or replicating EIs, thereby limiting their upscaling. Table 1 presents a summary of factors found in empirical peer-reviewed papers and scientific reports, from different scientific disciplines, reporting on factors that can positively or negatively influence energy conservation, thereby appearing as driver or barrier. Building on the categorization of van Doren et al. (2016), the factors identified in literature were classified into four general categories of the contextual environment of EIs. The socio-cultural context refers to a collection of factors related to the characteristics of the demand-side actors, including their level of awareness, values, attitudes, and capacity. Factors regarding the market context relate to the characteristics of ECMs, skills and experience of supply-side actors, and the conditions that enable demand-side actors to invest in the ECMs, such as information and credit availability. The policy context concerns the policy framework, such as legislation and policy leadership, which influence the ability and attractiveness to invest in ECMs. The built and geographical context, such as building characteristics and the climate, determine the potential for energy conservation. We expect that barriers to scaling-up might be diverse and depend on the type of building stock and urban context. This corresponds to the notion that while some barriers are always mentioned in studies, others are reported incidentally.

2.2. Local strategies to address barriers

The identification of barriers leads to knowledge on the conditions that need to be addressed in order to support the scaling-up of EIs. It is assumed that by removing a broad variety of barriers and creating facilitative conditions, the scaling-up of EIs can be accelerated. In this paper we explicitly look for local strategies that can

Table 1
Empirically observed factors influencing energy conservation, which can appear as barrier to the scaling-up of EIs. * signifies non-peer reviewed, 'grey' literature.

Category	Condition	Operational definition	Sources
Socio-cultural context	Environmental awareness	The level of awareness of demand-side actors on the possibilities and benefits of investing in ECMs.	Baek & Park (2012),*Emmert et al. (2011)*, Dowson et al. (2012), Kranzl et al. (2014)*, International Energy Agency, 2008*, Schimschar et al. (2011), Schleich (2009), Sherriff (2014), Steg (2008), Steg & Vlek (2009), Tuominen et al. (2012)
	Environmental values and attitudes	The values and attitudes of demand-side actors, such as concern for the environment and a moral commitment to use energy efficiently.	Ang & Wilkinson (2008), Baek & Park (2012), Bradford & Fraser (2008), van Bueren & Priemus (2002), Kranzl et al. (2014)*, Dowson et al. (2012), Emmert et al. (2011)* Farreny et al. (2011), Hoffman and Henn (2008), International Energy Agency (2008)*,Kranzl et al. (2014) * Schleich (2009), Schimschar et al. (2011), Sherriff (2014), Steg (2008), Steg & Vlek (2009), Stieß and Dunkelberg (2013), Sullivan et al. (2013), Tuominen et al. (2012), Waals et al. (2003), Williams & Dair (2007), Zhang et al. (2011)
	Resource capacity	The financial or informational resources and/or expertise that demand-side actors have to invest in ECMs.	Ang & Wilkinson (2008), Baek & Park (2012), Emmert et al. (2011)*, Bradford & Fraser (2008), van Bueren & Priemus (2002), Decanio (1998), Hoffman & Henn (2008), International Energy Agency (2008)*, Kostka et al. (2013), Kranzl et al. (2014) *, Middlemiss & Parrish (2010), Schleich (2009), Seyfang & Haxeltine (2012), Steg (2008), Sherriff (2014), Steg & Vlek (2009); Stieß & Dunkelberg (2013), Tuominen et al. (2012), Walker et al. (2007), Williams & Dair (2007), Williams et al. (2012)
Market context	Capital and instalment costs	The purchase and instalment costs of ECMs.	Baek & Park (2012), Emmert et al. (2011)* Brown and Vergragt (2008), Farreny et al. (2011), Hoffman & Henn (2008), International Energy Agency (2008)*,Kranzl et al. (2014)* Reddy & Painuly (2004); Schleich (2009), Sherriff (2014), Sullivan et al. (2013)
	Credit availability	Opportunities for demand-side actors to access credit to invest in ECMs.	Emmert et al. (2011)*, Beck and Martinot (2004)*, International Energy Agency (2008)*, Kostka et al. (2013), Kranzl et al. (2014) * Reddy & Painuly (2004), Schleich (2009), Tuominen et al. (2012), Sherriff (2014)
	Skills and expertise of supply-side actors	The technical, financial, and business development skills regarding ECMs among supply-side actors.	Emmert et al. (2011)*,Beck and Martinot (2004), International Energy Agency (2008)*, Kranzl et al. (2014) *Reddy & Painuly (2004), Sherriff (2014), Tuominen et al. (2012)
	Information availability	The level to which demand-side actors have low-cost access to good and reliable information on ECMs.	Baek & Park (2012), Kranzl et al. (2014)*, Emmert et al. (2011)*, International Energy Agency (2008)*,Kranzl et al. (2014) * Schleich (2009), Reddy & Painuly (2004), Baek and Park (2012), Sherriff (2014), Tuominen et al. (2012)
	Energy price	The financial price paid for energy consumption.	Emmert et al. (2011)* International Energy Agency (2008)*, Sullivan et al. (2013), Waals et al. (2003)
Policy context	Policy leadership	The level of political ambition regarding energy conservation of national and/or local governments.	Emmert et al. (2011)* Betsill (2001), Schreurs (2008), Granberg and Elander (2007), Romero-Lankao (2012), Sherriff (2014), Sullivan et al. (2013)
	Policy instruments	The regulative, financial, cooperative, and informative policy instruments influencing demand-side actors' decision to invest in ECMs.	Allen et al. (2012), Ang & Wilkinson 2008, Baek and Park (2012), Bomberg and McEwen (2012), Emmert et al. (2011)* Farreny et al. (2011), Hoffman and Henn (2008), Seyfang (2010), Stieß and Dunkelberg (2013), Tuominen et al. (2012), Walker et al. (2007), Williams et al. (2012), Zhang et al. (2011)
Built and geographical context	Built environment	The characteristics of the local built environment (such as urban form, grids for public utilities, building characteristics, and the ownership structure of buildings).	van Bueren & Priemus (2002), Farreny et al. (2011), Kranzl et al. (2014)* Nijkamp & Pepping (1998), Nijkamp & Cruickshank (2012), Tuominen et al. (2012), Williams et al. (2012)
	Geographical environment	The characteristics of the local geographical environment (such as natural resources and climatic conditions).	van Bueren & Priemus (2002), Farreny et al. (2011), Kranzl et al. (2014)*, Nijkamp & Pepping (1998), Pelenur & Cruickshank (2012), Williams et al. (2012)

address barriers. Strategy is defined following Mintzberg (1987) as a "consciously intended course of action, a set of guidelines to deal with a situation" (p. 11). A strategy has two key characteristics, namely they are made in advance of the actions to which they apply, and that they are developed consciously and purposely (Mintzberg, 1987). We search for strategies that have been applied by initiators of EIs to address barriers, and strategies that they deem appropriate for implementation by local government. Special

attention is paid to strategies that can be applied by local governments because local governments worldwide have been allocated, or have taken up, the policy mandate to promote energy conservation and low-carbon urban development (Khakee, 2010; Schreurs, 2008). Moreover, in their capacity to construct and operate urban infrastructures, oversee planning processes and establish local policies, local governments are deemed well equipped to implement local strategies that correspond with local needs and possibilities (see Agenda 21 UNCED; Caputo and Pasetti, 2015).

Building on the typology of governance instruments proposed by Vedung (1998) and Jordan et al. (2003) and strategies found in empirical studies (see Baek & Park, 2012; Farreny et al., 2011; Stoknes, 2014; Tuominen et al., 2012), we apply a fourfold configuration of local strategies: informative, cooperative, financial, and regulative strategies. Informative strategies focus on the provision of information and advice, such as information and advice programs or centres. Cooperative strategies are aimed at process guidance and improving the quality and efficiency of realizing EIs through partnerships, participatory management, and training programs. Financial strategies, such as purchasing agreements, trading mechanisms subsidies, and tax reliefs, strive to make EIs financially feasible and attractive. Finally, regulatory strategies, including building codes, zoning regulations, and installation performance specifications, are coercive measures to incentive the scaling-up EIs.

3. Research design

We apply a comparative embedded multiple-case study design in order to learn more about the barriers and local strategies to scaling-up EIs. This means that the analysis contains more than one sub-unit of analysis (Yin, 2014). We believe that an analysis of sub-units allows for a more detailed level of enquiry. The first sub-unit of analysis concerns the type of building stock: residential and commercial buildings. We have chosen EIs focused on energy conservation in these two building stocks because they are collectively responsible for the largest part of energy consumption in the urban building stock (UNEP, 2009). We assume to find differences pertaining to barriers related to the socio-cultural context as these two building types have different purposes and because the demand-side actors – households and commercial enterprises- that have to make the decision to conserve energy differ in terms of their motives and resource capacity. The second sub-unit of analysis refers to the contextual environment in which the EIs reside. We have chosen to compare different cities as it allows us to analyse similarities and differences in barriers related to the contextual conditions of the EIs. The cities of Utrecht and Valencia are selected for a number of reasons. Both cities are faced with the challenge of de-carbonizing the building stock. The local governments have set objectives in terms of low-carbon urban development, which implies a readiness to address the barriers to scaling-up EIs (Municipality of Utrecht, 2011; Municipality of Valencia, 2014). Moreover, various EIs focused on energy conservation in the existing building stock have already been realized in both cities (AViTeM & Government of Catalonia, 2014; Municipality of Utrecht, 2011). However, the cities significantly differ in terms of, amongst others, economic development, climate, urban form, and political climate. The variation between the Northern European and Mediterranean context allows us to explore differences in terms of socio-cultural, market, policy, and built and geographical contextual conditions that can act as barriers to the scaling-up of EIs.

Internal validity and richness of the data is achieved through triangulation. A combination of information sources is used including desk research and 28 stakeholder interviews. Through an analysis of EIs in the cities under analysis, stakeholders were recruited that have been directly involved in EIs. Their perspectives are deemed valuable because they have practical experiences concerning the barriers related to the uptake and growth of EIs. Moreover, as these actors are, or have been, proactively involved in trying to grow the initiative and involve a greater audience, they are also well informed about the barriers that impede other demand-side actors from engaging in EIs and how – and to what extent- such barriers can be addressed at the local level. Also, various interviews have been held with regional and national operating experts, who can reflect on the barriers and local strategies due to their wider experience in the field of energy conservation. Appendix A provides an overview of the initiatives and respondents, who have been anonymized in order to maintain respondent confidentiality. The interviews followed a basic script that contained –in line with our analytical framework- questions on barriers and local strategies to address barriers. For the identification of local strategies, a distinction has been made between strategies that have been applied by actors involved in EIs and strategies that are considered appropriate for implementation by local governments. A document analysis of (local) studies, policy documents, and reports on the EIs was conducted to enhance the internal validity of our interview findings. Conclusions in this paper are based on the inter-subjectivity of the responses: the agreement or consensus between respondents (Scheff, 2006). Yet, important disagreements between respondents are, when applicable, also noted. Responses were coded according to the analytical framework (see section 2) and factors were recorded as general barriers and strategies if they were reported by the majority of stakeholders (more than 50%). The results in the following section are presented in comparative perspective in order to improve our understanding of the context-specificity of barriers. Quotes of the respondents are used to illustrate the occurrences of barriers and local strategies.

4. Results

Table 2 and 3 provide an overview of respectively the barriers and local strategies to the scaling-up of EIs in residential and commercial buildings, identified by the majority of respondents in Utrecht and Valencia. The results will be discussed per type of building stock: residential (4.1) and commercial buildings (4.2). As a point of departure, an account will be provided of the barriers, categorized in accordance with our analytical framework, followed by an overview on local strategies that have been applied and suggested by the respondents.

4.1. Scaling-up energy conservation initiatives in residential buildings

4.1.1. Barriers

4.1.1.1. Socio-cultural context. Respondents in both cities note that while households are generally aware of the societal importance of climate change mitigation and energy conservation, they are often not well informed about the financial, health, and wellbeing benefits ECMs can generate for their own household. "*There is often still a lack of knowledge about the possibilities and personal advantages of energy conservation measures*" (respondent U3). It is argued that individuals with values and attitudes promoting sustainability are more likely to engage in EIs, but that even these actors do not always translate their values into practice due to other priorities within the household. "*Many people are in doubt. They are interested but push the decision forward because of practical concerns and priorities within the household*" (respondent U1). Moreover, even when households are aware and motivated to engage in EIs, they might lack the expertise, information, time, or financial capacity to do so. Respondents note that the issue of energy conservation

Table 2
Barriers to scaling-up EIs. Barrier perceptions by the majority of respondents in Utrecht and Valencia.

	Residential buildings		Commercial buildings	
Condition	Barriers in Utrecht	Barriers in Valencia	Barriers in Utrecht	Barriers in Valencia
Socio-cultural context				
Environmental awareness	Limited awareness on benefits and opportunities of ECMs for own household	Limited awareness on benefits and opportunities of ECMs for own household	Limited awareness on potential benefits and opportunities of ECMs for own enterprise	Limited awareness on potential benefits and opportunities of ECMs for own enterprise
Environmental values and attitudes	Energy conservation has no priority within the household	Energy conservation has no priority within the household	Energy conservation has no strategic priority as a result of the small percentage of energy costs of the total operating costs	Energy conservation has no strategic priority as a result of the small percentage of energy costs of the total operating costs
Resource capacity	No information and/or expertise ECMs	No information and/or expertise on ECMs; Limited financial capacity	No information and/of expertise on energy consumption patterns and ECMS; Lack of (internal access to) financial resources as a result of short-term investment horizons	No information and/or expertise on energy consumption patterns and ECMs; Lack of (internal access to) financial resources as a result of short-term investment horizont and limited financial capacity
Market context				
Capital and instalment costs	High upfront capital and instalment costs	High upfront capital and instalment costs	High upfront capital and instalment costs; Hidden production costs	High upfront capital and instalment costs; Hidden production costs
Credit availability	–	Limited opportunities to access credit at low costs	–	Limited public or private financing opportunities
Skills and expertise of supply-side actors	Limited collaboration between supply-side actors	Limited experience and training of, and collaboration between, supply-side actors	Limited collaboration between supply-side and maintenance actors	Limited experience and skills of, and collaboration between, supply-side and maintenance actors
Information availability	Information asymmetry; Difficulty of finding reliable and customized information on ECMs	Information asymmetry; Difficulty of finding reliable and customized information on ECMs	Information asymmetry; Difficulty of finding reliable and customized information on ECMs	Information asymmetry; Difficulty of finding reliable and customized information on ECMs
Energy price	–	–	Low energy tax for enterprises	Low energy tax for enterprises
Policy context				
Political leadership	–	Instability of the policy framework	–	Instability of the policy framework
Policy instruments	No regulatory requirements regarding the energy efficiency of existing buildings	Lack of, and dispersion of, public funds or subsidies; administrative complexity; No regulatory requirements regarding the energy efficiency of existing buildings	Environmental regulation on energy efficiency standards for enterprises not ambitious enough	No regulations or energy efficiency standards for commercial enterprises
Built and geographical context				
Built environment	Fragmented property ownership in certain neighbourhoods	High percentage of fragmented property ownership; Lack in owners' associations and governance structures to discuss energy conservation	Split-incentives; Fragmented property ownership; Landlord-tenant dilemma	Split-incentives; Fragmented property ownership; Landlord-tenant dilemma
Geographical environment	–	Mediterranean climate (moderate winters)	–	Mediterranean climate (moderate winters)

can be perceived as complex and many households do not possess the expertise or information required to make a decision. Lack of financial resources by households can also obstruct them from engaging in EIs and this barrier is especially prominent in the city of Valencia. Due to the impact of the financial crisis of 2008 (unemployment rate of 25%), households experience limited financial capacity to finance ECMs without external access to capital or funding opportunities.

4.1.1.2. Market context. Respondents in both cities consider 'information asymmetry' and 'lack of customized information provision' to be barriers. Information provision is online -oriented, dispersed, and the quotations offered can be abstract and not tailored to the personal needs of the customers. "*It is for interested consumers very difficult to obtain reliable and clear information*" (respondent V2). "*Many consumers have doubts on the objectivity of the information and advice provided by supply-side actors*" (respondent U13). Due to the high upfront capital and instalment costs of many ECMs, access to capital at relatively low costs is an important condition. 'Insufficient credit availability' is, however, considered a significant barrier in the city of Valencia. At present, there are limited opportunities for residents to access credit over the long-term at low costs (respondent V2, see also Tragopoulos and Sweatman, 2012). Moreover, especially for low-income households it can be challenging to access credit as they are often not 'credit-worthy'. In all, '*the financing of energy conservation in the existing building stock remains one of the key barriers in the city of Valencia*' (respondent V1). The successful EIs in Valencia were realized due to public funding. Yet, "*these resources are difficult to reproduce and such financing mechanisms are not viable on a long-term basis*" (respondent V2). Accordingly, alternative financing mechanisms need to be created in order to offer households different funding possibilities. 'Insufficient credit availability' is not perceived to be a barrier by the majority of respondents in Utrecht. Households can apply for long-term and low-interest energy saving loans, financed by the National Energy Saving Fund, and various financiers allow for the extension of mortgages for ECMs. The majority of respondents also perceive 'limited experience and training of, and collaboration between,

Table 3
Local strategies to scaling-up EIs. Applied and suggested strategies to scaling-up EIs in residential and commercial buildings by the majority of respondents in Utrecht and Valencia.

Category	Local strategy	Residential		Commercial		Barrier addressed
		Utrecht	Valencia	Utrecht	Valencia	
Informative	Customized, face-to-face communication regarding the financial and co-benefits (such as health and enhanced comfort)of ECMs	Applied	Applied	Applied	Applied	*Socio-cultural context:* lack of awareness on the benefits and opportunities of ECMs; Energy conservation has no priority within the household or enterprise
	Showcasing the impact of successful EIs	Applied	Applied	Applied	Applied	*Socio-cultural context*: lack of awareness on the benefits and opportunities of ECMs; energy conservation has no priority within the household or enterprise
	Dissemination of experiences and lessons learnt from EIs to peers and professionals	Applied	Applied	Applied	Applied	*Market context:* limited skills and expertise among supply-side actors
	Development of online and offline information points for customized and independent information provision and assistance	Suggested	Suggested	Suggested	Suggested	*Socio-cultural context*: limited information and expertise on ECMs *Market context:* information asymmetry
Cooperative	Process assistance from A to Z, including selecting suitable ECMs, financing, and finding of contractors	Applied	Applied	Applied	Applied	*Socio-cultural context:* limited information and expertise on ECMs *Market context:* information asymmetry; high production costs *Policy context:* dispersion of public funds; administrative complexity *Built and geographical context*: fragmented property ownership; landlord-tenant dilemma; lack in owners' associations and governance structures to discuss energy conservation
	Training of, and collaboration between, supply-side actors regarding ECMs	Suggested	Suggested	Suggested	Suggested	*Market context:* Limited skills and expertise of, and collaboration between, supply-side actors
	Activation of owners' organization and development of support structures for EIs in shared buildings	Suggested	Suggested	–	–	*Built and geographical context*: fragmented property ownership; lack in owners' associations and governance structures to discuss energy conservation
Financial	Collective purchasing	Applied	Applied	–	–	*Socio-cultural context*: limited financial capacity of households *Market context*: high upfront capital and instalment costs of ECMs
	Valorising the co-benefits of ECMs and EIs	–	–	Applied	Applied	*Socio-cultural context*: lack of awareness on the benefits of ECMs; Energy conservation has no priority within the household or enterprise
	Development of public and private financing mechanisms (e.g. revolving fund)	Suggested	Suggested	Suggested	Suggested	*Market context:* high upfront capital and instalment costs; limited opportunities to access credit at low-costs
Regulative	Development and enforcement of regulatory structures to establish owners' associations in collective buildings	–	Suggested	–	–	*Built and geographical context*: Fragmented property ownership; lack in owners' associations and governance structures to discuss energy conservation

supply-side actors' to be a barrier to scaling-up EIs. This barrier is found especially in Valencia where "*the energy refurbishment sector has not yet found momentum* [and] *limited skills and know-how on energy conservation can be found by professionals at all levels of the supply chain, from contractors to architects*" (respondent V10). In Utrecht, the level of expertise and skills regarding the instalment of ECMs can also vary greatly between contractors and installers. While there are certification schemes available and a national website to find certified and skilled supply-side actors, households are not always capable of finding this information and thus need assistance with this process.

4.1.1.3. Policy context. Respondents from both cities maintain that many households do not invest in energy conservation because of a lack in regulatory incentives. In accordance with the EU Energy Performance of Buildings Directive, the national buildings codes in Netherlands and Spain contain only requirements on energy efficiency levels for new buildings and major renovations. Respondents in Valencia also identify a lack of public funding opportunities to be a barrier to scaling-up EIs in the residential building stock. Budget cuts have been significant since the 2008 financial crisis, resulting in limited availability of public funds or subsidies. The few public grants that are available for ECMs at the national and regional level can be difficult to access due to slow and complex administrative procedures and dispersion of funds (respondent V2; AviTem & Government of Catalonia, 2014). Another barrier specific to the case of Valencia is perceived 'uncertainty of the policy framework'. Respondents in Valencia note that there is little confidence in the policy framework and the stability of public schemes regarding energy conservation and generation, as a result of amongst others retroactive changes to the national feed-in-tariff in 2013 and a fee for self-consumption ('sun tax').

4.1.1.4. Built and geographical context. The cases indicate that fragmented property ownership can impede the scaling-up of EIs in residential buildings, and this is especially a challenge in Valencia. The residential building stock is characterized by a high percentage of shared building blocks with a condominium ownership structure (70–86%), in which it can be very difficult to carry out EIs due to the need for at least 50% of shares and challenges of coordinating the decision-making processes (Conefrey & Fitz Gerald, 2010; Economidou et al., 2011; Kranzl et al., 2014). In many cases, there are no (active) owners' associations who could manage such a process (respondent V8). In Utrecht, it is for households in collective buildings mandatory to become a member of the owners' association, and thus there should be a governance structure in place to address issues related to energy conservation.

Respondents in Valencia consider the moderate Mediterranean climatic to be a barrier as it negatively influences the payback period of ECMs (see Tragopoulos & Sweatman 2012). "*Because of the moderate Mediterranean climate, there is a lower potential in energy conservation – particularly regarding heating – and thus the payback period of investing in energy conservation measures is longer compared to Northern European countries*" (respondent V2). Nevertheless, they argue that there is a great potential for energy savings because the Mediterranean climate has led to a low emphasis on insulation of the housing stock and an increase in the use of air conditioning (see AViTem & Government of Catalonia, 2014).

4.1.2. Local strategies

4.1.2.1. Applied strategies by initiators of EIs. Respondents stress the significance of *informative strategies* in order to address barriers such as lack of awareness, priority, information, and expertise on ECMs among households, and information asymmetry. EIs in both cities have been realized due to personal and customized information provision by independent and trusted, local actors. The EIs in Utrecht were led by community actors and the EIs in Valencia were initiated by the Valencia Institute of Building. An important advantage of customized communication by local actors is that communication can be tailored to the specific motivations and needs of the audience. Communication by peers is also used and advocated by EIs in Utrecht as it can encourage sustainable conduct through social norms and because people are more likely to adopt ECMs "*because the neighbours do it too*" (respondent U18). *Cooperative strategies* have also been applied by EIs in Utrecht and Valencia in order to address barriers including households' lack in time and expertise, information asymmetry, the dispersion of funds, administrative complexity, and fragmented property ownership. Respondents emphasize the importance of offering households support – from A to Z – by independent and trusted actors who can act as mediators. Successful initiatives in Valencia demonstrate that coordination and organizational barriers, inherent to shared building blocks with fragmented property ownership, can be diminished through participatory management and process guidance. Due to intermediation by experts, successful initiatives have been carried out in shared apartment blocks with more than 30 individual owners. Finally, the majority of EIs applied *financial strategies*, namely collective purchasing arrangements—to reduce capital and instalment costs.

4.1.2.2. Suggested strategies for local government. While private actors can apply the above-mentioned strategies, the majority of respondents also underlines the important role of local governments in supporting and institutionalizing such strategies. Local government can apply *informative strategies* in order to raise awareness and creating demand for EIs. This can be done through information platforms, campaigns, and demonstrating the impact of successful EIs. When doing this, "*local government should act as an example*" and initiate EIs in their own buildings and demonstrate what can be done and what the benefits of EIs are (V2). Respondents also highlight that as local and legitimate actors, local government could initiate and support *cooperative strategies*, such as the development of training programs and establishment of local offices where households can receive assistance and get connected with supply-side actors. "*Local government should focus on management and intermediation*" (V8) and can "*play an important role in linking supply and demand*" (respondent U13). Programs aimed at the training of, and collaboration between, local supply-side actors can be applied by local governments to encourage supply-side actors to work collectively in developing products or business models for EIs (e.g. packages of ECMs), thereby improving their quality and price (U5).

It is noted by some that whether local government should take the lead in developing and implementing informative and cooperative strategies is context-dependent. "*If there is a lot of 'energy' and expertise in a community, the local government does not have to take the lead but can rather mobilize and enable – through financial, technical, information, or political resources- other actors in their endeavour to realize and scale-up EIs*" (U4). "*This will enhance the chance that EIs will have a bottom-up character*" (U2). In communities with no or limited actors working on this issue, local government can take on a more directing role in which it initiates EIs and mobilizes, enthuses, and supports actors to cooperate.

As many local governments experience limitations in terms of public funding opportunities, they should pro-actively search for *financial strategies*. Financing arrangements, that are viable on a long-term basis and not susceptible to changes in the political context, can be developed in collaboration with local banks or investors (e.g. ESCOs, guarantees). If public funds are available they should be used systemically and incite a multiplying effect of public resources (e.g. creating a revolving fund for households with a low credit risk).

There is no consensus among respondents as to whether *regulative strategies* should be applied by local governments (e.g. energy performance standards). Some believe that, without financial and technical support, this will be a burden that many households cannot bear. Respondents in Valencia do reflect on the need for local government to apply regulative strategies to establish owners' associations and governance structures in buildings with a condominium ownership structure in order to address barriers concerning the complexity of decision-making about energy conservation in shared buildings.

4.2. Scaling-up energy conservation initiatives in commercial buildings

4.2.1. Barriers

4.2.1.1. Socio-cultural context. Energy conservation often has low strategic priority because "*energy costs are generally relatively small for commercial enterprises*" (2–4%) (respondent U7). Accordingly, the issue tends to receive less (strategic) attention in commercial buildings compared to energy-intensive industry sectors. Respondents note that there is a general lack of awareness about the long-term financial advantage and the various economic co-benefits of energy conservation, such as enhanced productivity, comfort, and wellbeing of employees. Also, "*a great majority is motivated and willing to save energy, but does not do it*" because they do not have, or do not want to discharge, capacity (such as financial and human resources). *"If business is going well, they don't have time, and if they do have time- business is likely not going well- they don't have the financial resources to make the investment*" (respondent U8). Moreover, it can be a challenge to gain internal access to capital due to investment criteria, such as the expected rate of return or payback period of investments. The application of relatively short payback periods can lead to the fact that investments in ECMs are not made regardless of the financial benefits in the long run. Finally, many small enterprises lack the information on individual levels of energy consumption and the expertise to develop effective responses.

4.2.1.2. Market context. The respondents indicate that there is a high-risk perception toward investments in ECMs because of their high upfront capital and instalment costs. The long payback period of ECMs is indirectly influenced by the price paid for energy by companies. Various respondents in both cities note that the burden of energy taxes is generally relatively low for enterprises in order to improve their international competitiveness, and that accordingly enterprises can lack a financial incentive to conserve energy. For those enterprises that are interested in conserving energy, it can be difficult to obtain reliable and customized information due to information asymmetry and complexity of the issue. Under such circumstances, gathering information on energy consumption patterns and suitable ECMs consumes much time and human resources, leading to high production costs. "*It takes too much precious time to start a search process and obtain clear and reliable information"* (respondent U8). Thus, there are hidden production costs related to investing in ECMs. Enterprises can also experience barriers related to external access to capital, such as lack in appropriate loan conditions. As for households, it can also be a challenge for enterprises in Valencia to access capital with low-interest rates over a long-term. Respondents in Utrecht do not report this barrier as enterprises can make use of various local loan schemes and national tax deduction schemes concerning investments in ECMs (see RVO, 2015). Finally, respondents in both cities argue that supply-side and maintenance actors do not always have sufficient experience or skills in ECMs and that there is generally limited collaboration and integration between the different actors involved in the maintenance of a building. To illustrate, "*if an installer has to replace a boiler, he will only be looking at this aspect of the building*" (respondent U7), thereby missing the identification of other energy conservation opportunities.

4.2.1.3. Policy context. Respondents indicate that regulations can be an important driver to persuade enterprises to invest in ECMs. The Dutch national Environmental Protection Law and Activity Decree sets standards for energy efficiency improvements and obliges enterprises to invest in ECMs that have a payback period of five years. Yet, respondents and previous studies indicate that this law is enforced peacemeal by authorities in the Netherlands, leading to the fact that many enterprises are unaware of this regulatory obligation (Vringer, van Middelkoop, & Hoogervorst, 2014). Moreover, respondents argue that this regulation is not ambitious enough in order to achieve national and international goals on energy conservation and climate mitigation. Enterprises operating in Valencia do not have the obligation to invest in ECMs. While national legislation has set rules and procedures to fulfil energy saving requirements for new buildings and major renovations, there is no specific legislation to limit energy consumption of buildings in use. Similar to the case of residential buildings, instability in the national policy framework concerning energy conservation and generation creates uncertainty and prevents enterprises from making investments with long-term payback periods (Cuchi and Sweatman, 2013).

4.2.1.4. Built and geographical context. Respondents in both cities note that in commercial buildings with fragmented property ownership or leased spaces, the 'landlord/tenant dilemma' can occur. Depending on the structure of the commercial leases, either the landlord or tenant might not have sufficient incentives to engage in EIs because respectively the landlord pays the investment and instalment costs whereas the tenant is the sole beneficiary, or the tenant is not motivated to collaborate because he pays an all-in price and thus has no incentive to reduce energy consumption. While these barriers can be overcome through effective communication and contracts on sharing costs and savings between the tenant and landlord, the costs for verifying cost-savings and contractual arrangements are often prohibitive. Also, it can be a challenge for a single tenant to get in contact with the landlord because many commercial building are owned by large (foreign) investment funds. "*Sometimes the contact between landlord and the enterprises leasing the buildings is almost inexistent*" (expert U7). Like the residential sector, the Mediterranean climate conditions (moderate winters) can negatively influence the payback period of ECMs in commercial buildings. Nevertheless, respondents emphasize that improved insulation, shading, and HVAC systems can enhance indoor quality levels, thereby improving work engagement, employees' wellbeing, and other aspects linked to business productivity.

4.2.2. Local strategies

4.2.2.1. Applied strategies by initiators of EIs. EIs in both cities have been developed using *informative* and *cooperative* strategies. EIs in Utrecht, run by private actors in cooperation with the local government, applied customized information provision and process assistance. When enterprises were interested and motivated to engage in EIs, they were guided during the entire process and assisted with selecting ECMs, finding installers, and arranging the financing. "*You have to take them by the hand throughout the entire process, from A to Z. By assisting and unburdening companies, they can invest in energy conservation without having to spent much time or resources. They only have to sign the contract*"(respondent U8). The EI in Valencia, run by the Valencia Institute of Building, focused on information provision, energy monitoring, process assistance, and intermediation between all stakeholders in the

building to identify appropriate solutions. Collaborative processes, guided by intermediaries, allow owners, tenants, and managers to identify and plan for cost-effectives ECMs at suitable moments (such as a tenant turnover). When applying cooperative strategies, collaboration between supply and maintenance actors should also be encouraged so that they stop working in silos and learn to apply an integrative perspective. "*The 'ecosystem' of a company – suppliers, service providers, accountants, maintenance workers – have to cooperate to ensure that energy conservation opportunities are identified*" (respondent U6). It is noted by respondents that the actors applying informative and cooperative strategies should have a position of trust and should offer companies assistance throughout the entire process (energy scan, finding installers, financing, arranging contracts, monitoring). *Financial strategies* have also been applied by EIs. As commercial enterprises will be likely attuned to the economic rationale of engaging in EIs, respondents highlight the need to communicate and valorise the co-benefits such as enhanced indoor quality, which leads to improved employee wellbeing and work engagement. The valorisation of co-benefits is especially important in the Mediterranean context, where the moderate winters and hot and dry summers lead to higher payback periods. Also, showcasing the experiences and financial benefits of peers is recommended as it can lead to a reduction in risk-perception among enterprises.

4.2.2.2. Suggested strategies for local government. Respondents argue that local governments can support private actors in the application of *informative* and *cooperative* strategies through the provision of financial, human, or organizational resources. The rationale for working through 'intermediaries', rather than directly through local government, is that enterprises are more likely to engage in EIs if they are informed and assisted by businesses within the same sector, or an actor with business experience "*who can speak the language of business*" (respondent U8). Local government can also proactively initiate *cooperative* and *financial* strategies, such as training programs and the creation of public and private mechanisms. Whether local governments can apply *regulatory strategies* is greatly influenced by their capacity and autonomy. EIs in Utrecht, realized in collaboration with the Municipality, indicate that national regulatory obligation to invest in energy can be strategically used to accelerate the scaling-up of EIs. The Municipality aims to encourage enterprises to cooperate in established EIs in commercial districts by using a facilitative approach, but simultaneously threatens to use regulative top-down instruments if these voluntary approaches are not successful.

5. Comparative analysis and reflection

We applied a comparative embedded multi-case study design to learn more about differences and similarities in barriers and local strategies to scaling-up EIs in residential and commercial buildings in different urban contextual environments: Utrecht and Valencia.

As for barriers, we assumed we would encounter differences in barriers related to the socio-cultural context between EIs in residential and commercial buildings as these two building types have different purposes and because the demand-side actors –households and commercial enterprises- who have to make the decision to adopt ECMs and engage in EIs differ in terms of their needs, attitudes, and capacity. While this assumption is partly supported by our results, we also find various important similarities in barriers. Commercial buildings differ from residential buildings in their patterns of energy use and management. Energy costs only constitute a small percentage of businesses' operating costs and consequently the issue often has low strategic priority. Moreover, as commercial enterprises often apply short-term investment horizons and short payback periods, internal access to financial resources to invest in ECMs can be impeded regardless of the significant financial benefits that the investment will generate in the long run (see Fleiter, Schleich, & Ravivanpong, 2012; Schleich, 2009). An important similarity is that both households and commercial enterprises often lack awareness, urgency, and capacity to invest in ECMs (see below).

The second sub-unit of analysis relates to the contextual environment in which the EIs reside. We have chosen to compare cities in different European regions as it allows us to analyse similarities and differences in barriers related to the contextual conditions of the EIs. In both Utrecht and Valencia, barriers related to the *socio-cultural context* were identified, such a lack of awareness and expertise among demand-side actors. These findings align with previous studies stating that there is still limited awareness and expertise regarding opportunities of ECMs and that, in consequence, the issue has limited urgency among demand-side actors (see Kranzl et al., 2014; Schleich, 2009; Steg, 2008; Tuominen et al., 2012). As for the *market context*, important similarities between Utrecht and Valencia include the high capital and instalment costs of ECMs, information asymmetry, and limited collaboration between supply-side actors. Due to the technical aspect of the issue and information asymmetry, it can be difficult for demand-side actors to find reliable and customized information and advice and accordingly investing in ECMs is associated with high production costs (see Baek & Park, 2012; Emmert et al., 2011; Kranzl et al., 2014; Reddy and Painuly, 2004; Schleich, 2009; Sherriff, 2014; Tuominen et al., 2012). Moreover, both cases reflect that due to the high upfront costs of ECMs, credit availability is an important condition for scaling-up (see Beck & Martinot 2004; Emmert et al., 2011; Reddy & Painuly 2004). Yet, the financial attractiveness of investing in ECMs is also indirectly influenced by energy prices. Due to energy subsidies, enterprises can pay a low price for energy, and this price distortion negatively influences the payback period of ECMs (see Emmert et al., 2011; International Energy Agency, 2008; Sullivan et al., 2013). Our findings indicate that a stable and facilitative *policy context* is also an important condition for scaling-up EIs (see Sherriff, 2014; Sullivan, Gouldson, & Webber, 2013). In Valencia, the instability of the national policy framework and limited funding public opportunities are considered important barriers as these conditions obstruct households and enterprises from making investments with long-payback periods. Finally, the findings indicate that conditions related to *the built and geographical context* influence the scaling-up potential of EIs. The Mediterranean climate and building ownership structure present challenges specific to Valencia. The Valencia case reveals that a high percentage of shared buildings and a lack in decision-making structures (e.g. owners' associations) can lead to inaction (i.e.Kranzl et al., 2014; Tuominen et al., 2012). In all, the findings suggest that Mediterranean environment of Valencia presents some specific contextual conditions that require special attention. Due to the limited 'financial capacity' of households and enterprises (as a result of the 2008 economic crisis), 'insufficient credit availability', 'lack of public funds', and the longer 'payback period of ECMs' because of the Mediterranean climate, the financing of energy conservation constitutes a key barrier to scaling-up EIs in the city of Valencia. Yet, while barriers can be context-specific, the results of this study underline the importance of applying an integrative perspective when examining barriers to scaling-up as such processes require facilitative conditions related to the socio-cultural, market, policy, *and* built and geographical context.

This paper also explored strategies that can be implemented at the local scale in furtherance of addressing barriers to scaling-up. The outcomes suggest that various barriers to scaling-up can be reduced at the local level. In line with previous studies,

the outcomes indicate that EIs are often initiated by enthusiastic 'frontrunners' who, due to their level of environmental concern and intrinsic enthusiasm in the process, are willing to combat many hurdles and apply strategies to expand the initiative and reach a greater audience (see Chmutina et al., 2014; Klein Woolthuis et al., 2013; Loorbach and Rotmans 2010; Seyfang, 2010). In both cases, initiator of EIs used informative and cooperative strategies to address barriers regarding the socio-cultural and market context. Socio-cultural barriers (e.g. lack of awareness, priority, and capacity of demand-side actors) and market barriers (e.g. information asymmetry) can be diminished through customized information provision and assistance by local, trusted, and independent actors. Information provision and assistance by local experts and peers (e.g. neighbours or other businesses) can have significant advantages because they enjoy communal trust, can tailor communication to the specific needs and interest of the audience, and make use of the power of peer review (see Dieperink, Brand, & Vermeulen, 2004; Stoknes, 2014). While the above signifies that many barriers can be addressed by private, local actors, it is important that such 'frontrunners' are supported in their endeavours and that the strategies they apply are implemented at a structural basis. Local government can play an important role in providing assistance and institutionalizing successful strategies in order to ensure their continuity. Support can be offered by local government through the provision of financial, technical, political, and even mental resources (e.g. acknowledgement). This implies a need for collaborative governance structures that combine the capacity of local, private actors (communal trust, local knowledge) with the structural resources and strength of local government (independency, continuity, resource capacity).

Yet, there are also limitations as to what private actors can do to address barriers. Market-related barriers, such as lack of training and expertise of supply-side actors, information asymmetry, and credit availability can only structurally be removed if major stakeholders (such as local supply-side actors, financing institutions, and local government) collaborate in the development of cooperative and financial strategies. Accordingly, there lies an important role for local government in initiating and supporting long-term strategies to address such barriers.

In all, the findings indicate that the local environment appears to be a suitable scale to address barriers to scaling-up. However, it must be acknowledged that there are also restrictions as to what can be done at the local level. Local governments differ in their capacity (e.g. human, financial, political, and regulatory resources) required to initiate and enable the implementation local strategies, and this capacity is significantly influenced by the national policy context (Betsill, 2001; Bulkeley & Kern, 2006). Moreover, barriers that have national or international sources, like energy pricing schemes, regulations concerning shared buildings, and European legislation regarding the energy performance of buildings, can only be effectively addressed at the national and international level.

6. Conclusion

Successful energy conservation initiatives have been realized that demonstrate the environmental, financial, and social benefits of energy conservation in buildings. However, in order to accomplish international goals on climate mitigation, the scaling-up – i.e. the increase in uptake, growth or replication – of such initiatives is needed well beyond what it happening today (Energy Efficiency Financial Institutions Group (EEFIG), 2014; Levine et al., 2007; UNEP 2009). This paper started with the notion that in order to accelerate the scaling-up of EIs, there is a need to deepen the knowledge base on barriers that demand-side actors, such as households and enterprises, experience in terms of adopting ECMs and strategies that can be applied at the local scale to address these barriers. The focus on local strategies is deemed relevant because whereas the local context is generally considered an appropriate scale for promoting the transition to a low-carbon society (Betsill & Bulkeley, 2006; Schreurs, 2008; Selman, 1998), there is need for a greater understanding of how local strategies can address barriers to mitigating the global problem of climate change (Betsill & Bulkeley 2006; Burch 2010; Rutherford & Jaglin, 2015). This paper aims to contribute to an improved understanding of barriers and local strategies to scaling-up energy conservation initiatives and has three general findings that can enrich literature and practice on urban climate governance. First, it has sketched the context-specificity of barriers to scaling-up EIs and has reflected on similarities and differences in barriers to energy conservation in residential and commercial buildings. The findings indicate that conditions related to the socio-cultural, market, policy, and built and geographical context can inhibit the scaling-up of initiatives and that such conditions can significantly differ between cities. Second, this paper has discussed several local strategies to overcome barriers, thereby improving our understanding of the relation between barriers and solutions. Finally, our findings indicate that while many barriers have national or international causes or dimensions, the local environment appears to be a suitable scale to address barriers. Initiators of EIs and other actors with an interest in scaling-up EIs can address important barriers, such as lack of awareness, priority, and resource capacity of demand-side actors, and information asymmetry through the application of informative and cooperative strategies. The findings suggest that local government can play an important role in supporting informative and cooperative strategies and pro-actively searching for financial and regulative strategies. In all, this paper contributes to an improved understanding of how low-carbon urban development can be promoted at the local scale. We suggest that additional work can be done to explore the extent to which the findings presented in this study are unique to the cities under study and to further develop an evidence-based repertoire of local strategies to accelerate the scaling-up of EIs. Because our findings also suggest that local governments can play an important role in addressing barriers, we propose that further research should explore the capacities required of local governments in order to initiate and facilitate the development of local strategies. As cities are at the forefront of climate action, the study and implementation of urban governance arrangements for addressing barriers to energy conservation in the built environment is greatly needed.

Appendix A. List of respondents and energy conservation initiatives.

Respondent	Position	Initiative	Date of interview
Case Utrecht			
U1	Initiator, community-led initiative	Community-led initiative focused on energy conservation and renewable energy generation in a residential neighborhood in Utrecht	23–03-2015
U2	Coordinator, community-led initiative Energie-U	Community-led initiative focused on energy conservation in residential buildings in Utrecht	24–03-2015
U3	Initiator, community-led initiative	Community-led initiative focused on energy conservation and renewable energy generation in a residential neighborhood in Utrecht	10–04-2015
U4	Initiator, community-led initiative	Community-led initiative focused on energy conservation and renewable energy generation in a residential neighborhood in Utrecht	16–07-15
U5	Energy ambassador, Energiesprong	National operating expert involved in various energy conservation projects in residential and rental buildings	13–08-2015
U6	Coordinator, Economic Board of Utrecht	Regional operating expert, involved in various energy conservation projects in residential and commercial buildings	02–09-2015
U7	Fund manager, Energy Fund Utrecht	Regional operating expert involved in various energy conservation projects in commercial buildings	13–05-2015
U8	Process manager, Municipality of Utrecht	Sustainable business district 'Sustainable Lage Weide', Utrecht	10–06-2015
U9	Process manager, independent consultant	Sustainable business park 'Rijnsweerd', Utrecht	02–07-2015
U10	Process manager and business developer, Grontmij	Sustainable business Park 'Papendorp' and sustainable office park 'De Weterin Haarrijn', Utrecht	21–07-2015
U11	Process manager, MKB Nederland	Initiative 'Green Deal SMEs in Utrecht' and 'Sustainable Office Initiative Utrecht'	14–08-2015
U12	Co-program manager Utrechtse Energie, Municipality of Utrecht	Regional operating expert involved in various energy conservation projects in commercial buildings in Utrecht	10–07-2015
U13	Energy advisor, Energieloket	National operating expert involved in various energy conservation projects in residential and commercial buildings	05–06-2015
U14	Energy advisor, Energieloket	National operating expert involved in various energy conservation projects in residential and commercial buildings	05–06-2055
U15	Advisor and manager energy efficiency, DCMR	National operating expert involved in various energy conservation projects in commercial buildings	09–07-2015
U16	Advisor energy efficiency, DCMR	National operating expert involved in various energy conservation projects in commercial buildings	11–08-2015
U17	Consultant and installer energy conservation measures, Wolter and Dros	National operating expert involved in various energy conservation projects in commercial buildings	03–07-2015
U18	Consultant and coordinator, Klimaatverbond	National operating expert involved in various energy conservation projects in residential buildings	04–06-2015
Case Valencia			
V1	Architect and consultant, Valencia Institute of Building	Pilot project 'Elih-Med': energy retrofitting of two apartment blocks in Valencia: Fontanares and Pio XII. Initiated by the Valencia Institute of Building.	14–09-2015
V2	Architect and consultant, Valencia Institute of Building	Pilot project 'Elih-Med': energy retrofitting of two apartment blocks in Valencia: Fontanares and Pio XII. Initiated by the Valencia Institute of Building.	14–09-2015
V3	Architect and consultant, Valencia Institute of Building	Smart and Sustainable Office Project Valencia, led by the Valencia Institute of Building.	10–09-2015
V4	Architect and consultant, Valencia Institute of Building	Smart and Sustainable Office Project Valencia, led by the Valencia Institute of Building.	05–10-2015; 18-09-2015
V5	Researcher and consultant energy conservation	Regional operating expert in the field of sustainable buildings	05–10-2015
V6	Researchers and coordinator, University of Valencia	Smart and Sustainable Office project Valencia, led by the Valencia Institute of Building.	20–10-2015
V7	Architect and consultant, Valencia Institute of Building	Smart and Sustainable Office Project Valencia, led by the Valencia Institute of Building.	18–09-2015
V8	Architect and professor in urban planning and sustainability	National operating expert in the field of sustainable buildings	15–10-2015
V9	Engineer and energy consultant, La Ribera Energy Agency	Regional operating expert involved in various initiatives focused on awareness raising and behavioural change regarding energy conservation in Valencia.	15–10-2015
V10	Architect	Regional operating expert in the field of sustainable buildings	15–10-2015

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