Energy retrofitting of urban buildings: A socio-spatial analysis of three mid-sized Italian cities

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ABSTRACT

The current paper analyses the issue of energy retrofitting of buildings in Italian cities. In particular a mixed-method approach is used combining the socio-spatial analysis of data on the most relevant policy tool, namely tax deduction, together with qualitative analysis of three case studies of middle-sized cities. The results show that on the one hand tax deduction has not been very effective in promoting a deep renovation of buildings and it may exacerbate already existing inequalities. On the other hand, it emerges that progress in eco-retrofit of buildings depends mainly on creation of new intermediators and intermediation incentives. They are increasingly necessary in an urban panorama that has become inevitably polycentric.

1. Introduction

The paper deals with retrofitting of buildings for increasing their comfort and energy saving. The article has two purposes. The first objective is to investigate the socio-spatial dimensions of energy retrofit policies in Italy in the last ten years. The second objective concerns the patterns of interrelation between demand and supply of retrofit at the local level. In order to achieve these objectives, we will draw on those approaches that highlight intermediation among private companies, institutions and no profit organizations. A model of these intermediations will be elaborated and three Italian cases, highlighting different balances among market, institutions and third sector, will be analysed. The model will be justified with sociological literature analysis and with a historical analysis of housing policies in Italy, especially focused on the tax reduction for retrofit. National legislative frameworks and local intermediation with construction sector explain the form and the scale of buildings retrofit projects in Italy.

2. Sociological approaches to energy retrofit

Sociological research on low energy retrofit can be grouped into two broad streams. On the one hand, a number of studies have adopted a behavioural approach trying to identify varied explanations of the slow diffusion of retrofit interventions among citizens and homeowners. On the other hand, recent research has focused on actors and processes of intermediation between demand and supply of retrofit.

As pointed out by Wilson et al. (2015), until recently applied behavioural research focusing on the identification of personal and contextual influences on the decisions of homeowners has been dominant. This research appears particularly useful in explaining the failure of policy tools, like energy certification and tax deduction considered in section 3. In particular, attention has been paid to cognitive and economic factors.

Cognitive factors refer to the lack of appropriate knowledge of homeowners. The literature highlights how they often receive inconsistent information from professionals and utilities on types of measures – both technologies and construction techniques - to be implemented, their convenience and effectiveness in addressing energy efficiency. This is often linked to different educational and working paths of professionals themselves (Virkki-Hatakka et al., 2013). To this must be added the emerging issue of the unintended consequences of retrofit in terms of the comfort and healthiness of housing (Davies & Oreszczyn, 2012). The difficulty of achieving a clear evaluation of the possible options due to lack of knowledge and contrasting views among professionals makes consumers skeptical of new opportunities and hinders change.

As regards the economic factors, the literature analyses the attitudes of home owners and businesses in light of the cost/benefit ratio. On the one hand, the owners generally consider the investment in energy redevelopment too risky and belated in terms of returns (Pelenurr &

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Cruickshank, 2012b); designers, on the other hand, consider the calculation of cost savings obtainable by retrofit very difficult to evaluate due to a number of factors. Among them there are the oft-cited trends of energy prices over time and the behaviour of users who, through their 'lay' and often 'consumeristic' practices, are likely to thwart the possible economic and environmental benefits of retrofitting (the so-called 'energy performance gap'). In particular, studies on the rebound effect (Greening et al., 2000) have shown that energy upgrading may induce an overall increase in consumption due to the adoption of irresponsible behaviours or ones inconsistent with expert prescriptions.

At present the majority of policy measures have sought to modify the cost/benefit ratio by adopting market-based instruments (Maller et al., 2011). This is the case of *certifications* and the various types of *incentives* that appeal to the sensitivity of owners and an alleged economic rationality that should lead to investments made to save on running costs (Vergragt and Halina, 2012).

The weaknesses of the tools here considered reflect the limitations of an individualistic and rationalistic stance which characterizes social behavioural approaches. The sociological literature on energy retrofit has thus increasingly distanced itself from a behavioural approach and alternative perspectives have been developed.

In particular, a growing attention has been paid to the need to develop a deeper engagement between supply side actors (contractors, installers, product manufactures, local authorities etc.) and homeowners and their lives. If this does not happen, the risk is that supply side actors will act as barriers rather than enablers.

Linked to this, an emerging stream of literature on energy retrofit has recently begun to focus on the role of *intermediaries* connecting homeowners to supply side actors of low carbon retrofit procedures, products and technologies (Grandclement et al., 2015; De Wilde and Spaargaren, 2018).

The low-carbon retrofit field is characterized by a 'balkanized' setting where procedures, providers and products are highly segmented and uncertain and where the demands, desires and experiences of homeowners are often neglected. This highlights the importance of focusing on a 'middle-out' perspective, which investigates the role of intermediary organizations working to create trust in a highly uncertain context. As highlighted by a number of studies (Moss, 2009; Hargreaves et al., 2013; Bird and Barnes, 2014; Warbroek et al., 2018), intermediaries can be of different kinds and can perform different functions.

They can range from public agencies, to public private partnerships (PPP) to civil society organizations (Rohracher, 2009; Guy et al., 2011; Grandclément et al., 2015; De Wilde and Spaargaren, 2018). They can perform different functions like: developing links between different organizations and actors; creating arenas for new ways of thinking and dealing with energy (Moss, 2009); aligning interests and creating conditions for learning processes (Kivimaa, 2014; van Lente et al., 2003); with particular regard to the retrofit issue, managing the retrofit demand through the design of different customer-journeys (De Wilde and Spaargaren, 2018). This literature represents the basis for the analysis undertaken in section 4 focused on patterns of intermediation in the retrofit field in three Italian cities.

3. Trends of urbanization and retrofit policies in Italy

The analysis of the retrofit issue in Italy requires prior description of some characteristics of the phenomenon of urbanization in Italy, in order to stress some features concerning both the demand and supply of retrofit and to highlight the key policy tools adopted at the national level.

As pointed out by Osti (2015), Italy experienced the emergence of three strongly connected trends after the Second World War: re-qualification of historic centres, urban-rural sprawl, growth of dense suburbs. These urbanization trends were characterized by a mix of expansion of existing buildings and construction of new buildings. The latter, however, played a dominant role. This clearly emerges from national statistical data, which show that while in 1951 there were about 11 million houses, in 2011 they had reached 31 million.

The building boom was characterized by a lack of attention to the quality of the building, especially as regards thermal and acoustic insulation (Caputo & Pasetti, 2015). This is also due to the fact that 70% of the homes in Italy were built before 1973, when a first law on energy efficiency in the building sector was adopted (Carrosio, 2015).

Nonetheless, in spite of the need for in depth requalification processes, we currently do not witness in Italy either large-scale projects involving condominiums and neighbourhoods, or a spread of radical interventions by individual owners. As highlighted by Carrosio (2015), since 2000 only 20% of homes have been renovated and only 30% of the interventions have concerned energy performance.

In general, restructuring without demolition is very limited. The transformation of the use of former industrial areas, which entails total reconstruction, is more common but often with not too stringent energy-environmental criteria. The largest and most important renovations concern public buildings and commercial private compounds.

This trend primarily reflects some problems on the supply side of energy retrofit, namely the construction industry. Large construction companies are looking for large economies of scale that require highly standardized restructuring processes. However, these are not suitable for the diversified Italian building stock. On the other hand, small businesses, which would be more suitable for the purpose, do not have the financial capacity to address the core of the issue represented by condominiums.

To these difficulties one has to add problems concerning the demand side of retrofit, that is, the residents. Although real estate investment (in the form of property) has represented, especially in the years prior to the 2008 crisis, one of the most important forms of savings for Italian families, investment in energy retrofits has been slow to take off. To explain this, the importance of two socio-psychological factors need to be highlighted: the difficulty in perceiving the economic and comfort improvement deriving from the energy-environmental restructuring, and the preference, in a situation of economic crisis, to maintain savings liquid (Osti, 2015).

In addition, the limits of current support policies for urban retrofit in Italy need to be considered. In Italy the most important tools in terms of financial resources and strategic investments to relaunch low energy retrofit of existing buildings have been a mix of regulatory tools and persuasive devices.

Regulatory policies concern tools such as building regulations and certification obligations in the case of the sale, lease and in some regions requalification of a building. They impose an obligation to adapt to the requirements, but tend to produce limited interventions because they often set medium-low standards. In Italy the most important regulatory instrument is the national system of energy certifications, which were made mandatory in the case of leasing and sale by the legislative decree 192/2005, which introduced the energy performance certificate. The purpose of this decree was to induce the market to recognize the energy performance of a building through the mechanisms of reputation and price.[1] However, it does not seem to have succeeded in doing so. As Carrosio highlights (2015), this is also due to the fact that the organizational field of energy retrofit is still in a consolidating phase characterised by various pressures from professionals, certification institutes and companies to conquer important positions. The result is the co-existence of various bodies that promote different protocols for certification, in competition with each other (e.g. Casa Clima; Leeds).

Persuasive policies, on the other hand, involve voluntary actions on the part of the actors. These include tax incentives like tax deductions,

[1] As regards certifications, regions have the possibility to introduce more stringent criteria, adopt certification registers, introduce standardized procedures in the certification methodology.

volumetric bonuses in the case of energy requalification, and incentives for the adoption of particular devices. Like regulatory policies, they are characterized as market-based policy tools, which are successful when there is a flourishing construction and real estate market and there are financial resources and the possibility of access to credit by households and businesses (Goulder & Parry, 2008).

In Italy the most important persuasive policy tool is the system of tax deductions of 65% for energy efficiency interventions (so-called eco-bonus), introduced in 2007, which allows individual citizens to intervene in their homes freely choosing among a range of technological options (Enea, 2018). Tax deductions are indeed the most widely used incentive for energy retrofit. For this reason, the next section will analyse in depth the distribution and effects of this specific measure.

Finally, in relation to energy retrofit we can also have redistributive policies, which refer to interventions of retrofit on social housing. Often, these types of intervention use the energy issue as an element able to catalyze a series of functional interests for regeneration of entire urban areas. These interventions can find forms of financing through the structural funds of the European Union. During the past few years, in Italy, some pioneering attempts to provide affordable and energy-efficient dwellings have begun to emerge (Copiello & Bonifaci, 2015). However, interventions of this kind remain marginal in the Italian context.

4. Tax deduction and energy retrofit: a socio-spatial analysis

According to many observers, the incentive mechanisms of energy retrofits related to tax deductions have been successful means to oppose the crisis in the construction industry (Conticelli et al., 2017). In fact, tax deductions have also the objective of acting on the contraction of the construction market, making economically advantageous those interventions that otherwise would not be made according to the current rules of the market. According to a recent study, between 2008 and 2016 - years in which the incentive tool was activated - tax deductions generated 34 billion euros of investments, making it possible to curb the loss of employment in the construction sector. In ten years, more than 12 million energy retrofit interventions have been carried out, for a total expenditure of approximately € 11 billion tax deducted. According to some estimates (Cresme, 2017), the incentive economy has allowed about 100 thousand workers each year not to lose their jobs.

Despite the significant financial effort, tax deductions did not seem to have produced structured global retrofit of buildings, essentially for two reasons.

First of all, as emerges from Table 1 they were used as a means to modernize homes, especially with partial interventions to replace windows and boilers for heating.

The incentive system has rewarded the simplest and unitarily cheaper interventions compared to global interventions that are more expensive, but more effective in terms of reducing consumption and emissions and with a more virtuous relationship between investment and energy savings. The replacement of windows is in fact the least effective type of intervention from the point of view of energy saving and reduction of climate-altering emissions, and therefore more expensive in relation to the costs and savings achieved.

Table 1
Types of intervention with the tax deduction tool.

Vertical walls	11.40%
Horizontal walls	18.30%
Windows	46.00%
Solar panels	2.40%
Sunscreens	2.60%
Condensing boilers	14.90%
Geothermal systems	0.10%
Heat pumps	3.10%
Water heaters	0.60%
Building automation	0.10%
Other	0.40%

Source: Own elaborations on Enea, 2008–2017 data

Secondly there is a growing part of the population that due to tax incapacity does not find the deduction system attractive and therefore does not have any kind of incentive to make interventions in their own homes. This last factor is closely linked to the risk that policy tools that incentivize people's behaviour act unequally on the population. In this case, they redistribute wealth from the less wealthy to the richer classes. This seems indeed to be confirmed by data reported in Table 2.

As shown by the data, in percentage terms the higher income classes have benefited from the deductions more than the lower income classes, in terms of both the number of deductions and the amount of money deducted. Both the increase of the quota deducted and the frequency of deductions are directly proportional to the income class. This happens because of (i) a greater propensity and possibility of investment, and (ii) a greater ability to access knowledge useful to perform deductions. Inequality in access possibilities must be integrated with the theme of *capabilities*. There is not only a problem of household purchasing capacity; there is also a problem of the lack of cognitive tools. This empirical evidence raises the question of whether and to what extent the emergence of an urban policy of environmental change in general - and energy retrofits in particular - ends up by exacerbating social and spatial inequalities in wealth and access to services (Bulkeley et al., 2014).

Tax deduction has effects not only on social inequalities. If we compare income investments on a regional scale (Table 3), marked territorial differences are apparent. The value of investments must first be standardized for the Heating Degree Day (Hdd) - an indicator designed to quantify the demand for energy needed to heat a building - and for the total Net Available Income (Nai). In this way one avoids the error of being influenced by climate and wealth conditions in the reading of the spatial distribution of retrofit interventions.

With the same heating needs and disposable income, the distribution of the indicator shows that the regions with the best performances are Veneto, Trentino Alto Adige and Valle d'Aosta. In general, all regions of the North have good performances, except for Liguria. In the south, Sicily and Puglia stand out for better performances than other regions. We can define these differences as socio-territorial: factors such as the structure of companies, the capacity for innovation, social capital and local industrial paths are important in shaping retrofit practices.

5. Model and methods

The above-highlighted data show that the majority of income investments in retrofit interventions are concentrated in Northern Italy, with some differences between the North-East regions, which appear the most virtuous, and the North-West areas, which are just behind, probably because the buildings scale is smaller in the North East and it is easier to intervene. Small/medium towns are the places where the majority of Italian population live. In addition, they tend to have better conditions and performances (Caputo & Pasetti, 2015). For these reasons we chose to focus on three small/middle-size towns of Northern Italy for a qualitative in-depth analysis: they were Padua (population of about 210,000 inhabitants), Alessandria (population of about 94,000 inhabitants) and Bolzano/Bozen (population of about 105,000 inhabitants). The aim was to better qualify the dynamics of retrofit with regard to socio-territorial characteristics. Thus, the general model for addressing retrofit is based on three spatial scales: national policy of incentives, regional differences in their application and, finally, three mid-size towns where measures were socially embedded.

Other reasons for choosing these towns were: 1) middle urban scale allows to control better processes that can be too complex in the metropolis, for example due to the intervention of multinational companies; 2) the three chosen towns represent respectively north west (Alessandria), north east (Padua) and extreme north (Bozen); 3) The three towns are different also for their income structure: Bozen (GDP per capita of 19,744 euro in 2016) and Padua (GDP per capita of 19,659

Table 2
Tax deductions for energy retrofit by income class, 2008–2016, Italy.

Income classes in Euros	Total frequency 2008–2016	Deductions for energy retrofit interventions		Interventions on the number of tax payers %	Average amount of deduction per income class
		Total number of tax payers 2008–2016	Amount in thousand Euros 2008–2016		Amount in Euros
less than -1000	13505	1362149	12657	0.99	937,21
from -1000 to 0	2527	369710	1993	0.68	788,68
zero	15889	4565394	11311	0.35	711,88
from 0 to 1000	51571	20385174	30585	0.25	593,07
from 1000 to 1500	19443	5716386	11197	0.34	575,89
from 1500 to 2000	16914	4865076	9810	0.35	579,99
from 2000 to 2500	16935	4374991	9493	0.39	560,56
from 2500 to 3000	17747	4069894	9428	0.44	531,24
from 3000 to 3500	17403	3597030	9432	0.48	541,98
from 3500 to 4000	18053	3528731	9638	0.51	533,87
from 4000 to 5000	39088	6929655	21128	0.56	540,52
from 5000 to 6000	42135	10908731	22897	0.39	543,42
from 6000 to 7500	81426	24039986	41733	0.34	512,53
from 7500 to 10000	203452	26973501	101102	0.75	496,93
from 10000 to 12000	276296	21897117	139735	1.26	505,74
from 12000 to 15000	563818	32239141	310182	1.75	550,15
from 15000 to 20000	1499977	57684750	922579	2.60	615,06
from 20000 to 26000	2322264	54504619	1623721	4.26	699,20
from 26000 to 29000	1077543	18883050	820376	5.71	761,34
from 29000 to 35000	1684674	24202273	1365448	6.96	810,51
from 35000 to 40000	915467	10923041	813366	8.38	888,47
from 40000 to 50000	1078906	11064364	1088912	9.75	1009,27
from 50000 to 55000	341028	3120728	389727	10.93	1142,80
from 55000 to 60000	272316	2376339	324512	11.46	1191,67
from 60000 to 70000	410199	3431726	517471	11.95	1261,51
from 70000 to 75000	163362	1315064	217192	12.42	1329,51
from 75000 to 80000	141409	1098526	193403	12.87	1367,69
from 80000 to 90000	221769	1631355	320042	13.59	1443,13
from 90000 to 100000	160494	1121355	249718	14.31	1555,93
from 100000 to 120000	208779	1374201	354135	15.19	1696,22
from 120000 to 150000	164603	1008549	305512	16.32	1856,05
from 150000 to 200000	121951	688931	262757	17.70	2154,61
from 200000 to 300000	88452	480463	248697	18.41	2811,66
More than 300000	54376	224358	164888	24.24	3032,37
TOTALE	12323771	370956358	10934784	3.32	887,29

Source: our elaboration on Ministry of Economy and Finance data, 2017.

Table 3
Investments on a regional scale standardized for the Heating Degree Day and for the Net Available Income.

Region	Hdd/Nai
Piemonte	137,7
Valle d'Aosta	211,4
Liguria	68,1
Lombardia	176,7
Trentino Alto Adige	212,3
Veneto	217,6
Friuli Venezia Giulia	197,4
Emilia Romagna	181,6
Toscana	145,6
Umbria	92,8
Marche	97,2
Lazio	70,1
Abruzzo	99,3
Molise	36,2
Campania	49,6
Puglia	74,4
Basilicata	111
Calabria	56,2
Sicilia	135,6
Sardegna	139,3

Source: Own calculations on Ministry of Economy and Finance, 2008–2017 data

euro) are richer than Alessandria (GDP per capita of 15,606 euro); 4) all the three cities are known for some retrofit projects, so there is a local institutional knowledge of retrofit issues. In general, cases selection aims to have as much as possible socio-spatial variability, keeping under control the main Italian divide, that is north-south.

In the analysis a mixed-methods approach to urban retrofit which integrated quantitative analysis with qualitative research was adopted. For case studies we used qualitative analysis of secondary and grey literatures. Each case-study comprised a number of 5 semi-structured interviews with key informants from local institutions, local certifying bodies and local associations. They were conducted in 2014 and were then updated in 2018 in order to track evolution processes. The themes investigated during the interviews concerned key initiatives on retrofit of both public and private buildings undertaken in the last ten years and the key actors engaged in the process. The focus of analysis of the local case-studies is on the identification of intermediation style according to a triadic model (Table 4).

Our analysis consists of identifying a number of general arrangements dominating the construction and real estate sector. They can be framed both in the literature of urban regimes (Della Porta, 2006) and in the so-called triadic models based on the distinction between market, hierarchy and network forms of organization (Powell, 1990). Urban regimes as well as triadic models assume quite variable forms and composition. In fact, in Table 4 they are presented as assembled either in the corporatist regime or in a dimension called 'block'. The latter indicates the high cohesion of local society due to structural factors, like ethnic identity, mass party subculture, or tragic events of the past. Furthermore, triadic models can be thought as overcoming urban regimes models conceived as a compromise or a dialectic between state and market.

Table 4
Types of local construction and real estate sector arrangements on building retrofit.

	Dynamics of retrofit		
Local institutional arrangements	Static	Path dependency or projects chain	Intermediation development
Market (dispersed operators)			
Market-Institutions (corporatist)			
Market-Institutions-Civil Society (block)			

The row dimensions of Table 4 are less general. They have been elaborated according to the small literature on retrofit and to preliminary observations of Italian case. Anyway, it is possible to give them theoretical dignity. Static situation deserves no explanation, while path dependency has been formulated also in terms of projects chain. It refers to a typical situation created with international bids promoted by European Union, Foundations and other no-profit organizations. The ability to elaborate projects and win public bids create a sort of chain effect: initial winners are able to achieve further funds, knowledge and entrepreneurship. That limits the access to such provisions by other organizations, creating a path dependency. Intermediation has been recognised as crucial in environmental projects; the same we expect for retrofit. Intermediation is here considered as a process allowing to overcome static or rigid situations. In fact, intermediators, if they enjoy general trust, can be a bridge between detached networks, as Granovetter (1982) and Burt (1992) respectively indicate with the concepts of bridge-ties and structural holes.

With this framework and knowing the impact of tax deduction policies we can try to formulate a more sociological hypothesis for the three case studies. Building retrofit actions at local level become more incisive when a loosely defined no-profit organisation is engaged in the field and is able to break the insulation of construction sector, connecting it with public administration, environmental agencies, consumer movements and epistemic communities.

6. The local level: A comparison of three mid-sized towns

6.1. The case of Alessandria

The city of Alessandria emerged as a forerunner in the energy retrofit process in Italy. As early as the mid-1990s Alessandria undertook a series of urban redevelopment initiatives concentrated in the Christ district. The interventions carried out over a twenty-year period were made possible by a chain of projects, implemented through a technical control room within the Municipality of Alessandria and an alliance between institutions and construction companies. This intermediation effort promoted a coherent project path focused on improvement of the district's livability together with the improvement of the energy performance of existing buildings and the construction of new homes according to criteria of urban sustainability.

The starting point can be traced back to the 1950s and 1960s, when as result of demographic growth and inflows of refugees from Dalmatia and Istria new public housing was built. From the mid-90s the problem arose of intervening on the district to renovate the existing building stock and to make the area more livable, creating spaces to promote the integration and participation of inhabitants. In the same years, the city of Alexandria was hit by a serious flood and this event created an emergency housing problem throughout the city, with the need to build new homes.

In this context, there emerged the idea of building new houses in the Christo district, which were going to be characterized by photovoltaic systems for energy production.

The Photovoltaic Village, whose construction began at the end of the 1990s, was the first step in a series of interventions aimed at redeveloping the district from an energy perspective. It concerned a total of 304 homes, including social housing, cooperative properties and private properties. The accommodations served by photovoltaic panels were 192 for an installed power capacity of 163 KWp.

The design chain started with the Photovoltaic Village. It was followed by a succession of incrementally four large urban redevelopment projects, having as a guiding principle the integration of devices for the production of electricity and heat from renewable sources in new buildings and in the restructuring of existing ones.

The projects were carried out on the initiative of municipal officials under the direction of the Department for territorial and strategic

development and through the creation of a control room, namely the Consulta of Residential Construction Operators, bringing together the Territorial Home Agency, building cooperatives, the consortium of private construction operators and, as observers, the Municipality, the Province, the Region and local savings banks.

This intermediary body has over time been able to maintain one strategic vision of interventions and complement different forms of financing: European funds, ministerial funds, regional funds, municipal and private resources.

The same coalition of actors which implemented the Photovoltaic Village project in the first half of the 2000s took part in the regional call for "neighborhood contracts", subsidized by the Ministry of Infrastructures, with the objective of increasing social integration of the inhabitants of the Christ district and adapt the housing supply. The project, called *Al-Via Village* implemented between 2008 and 2014 appears to be a mix of energy retrofit interventions and construction of new accommodation with criteria of environmental sustainability.

Recently, the project has been integrated and expanded by the EU funded project *Concerto AL – Piano*. The interventions planned in addition to those included in the *Al-Via* project have been: the energy diagnosis of about 3,000 houses in the district and the energy retrofitting of 450 homes; the construction of a biomass trigeneration network.

Last in chronological order has been the EU funded Project Practice Energy, which provides for the adoption of a series of "non-technological" actions promoting the emergence in the local community of sustainable behaviors and energy choices with the aim of contributing to the formation of a Sustainable Energy Community (Sec). Some of the results of this project have been: the involvement of local actors in the project to define the guidelines of the municipal energy plan; the promotion of communication and training activities for citizens on the themes of savings and energy redevelopment of buildings; the adoption of some small initiatives, such as LED public lighting in some streets of the city and the monitoring the electricity consumption of municipal buildings. Finally, a survey has been conducted on the level of awareness of energy issues of the inhabitants.

As highlighted in Table 5, in the case of Alessandria the local institutional arrangement for energy retrofit can be characterized as corporatist, i.e. based on a close relationship between state and market. The evolution of initiatives in this context followed a path-dependency logic, i.e. the local organizational field evolved according to a dependence on previous exogenous projects and sources.

6.2. The case of Bolzano/Bozen

In the national panorama, the case of Bozen, located in the autonomous German-speaking region of Alto-Adige/SudTyrol, has been traditionally characterized by particular attention to environmental sustainability. At the origin of these principles is the search for urban development that reduces the impact of the capital city on the surrounding alpine landscape. Moreover, the Masterplan of the municipality of Bolzano, which is characterized by the centrality given to the issue of reducing CO2 emissions, in accordance with the Covenant of Mayors, in relation to both the new construction areas on the outskirts of the city, and to the redevelopment of the existing buildings (Verones & Zanon, 2012).

Table 5
The buildings retrofit field in three Italian cities.

	Dynamics of retrofit		
Local institutional arrangements	Static	Path dependency or projects chain	Intermediation development
Market (dispersed operators)	Padova		
Market-Institutions (corporatist)		Alessandria	
Market-Institutions-Civil Society (block)			Bozen

With regard to energy retrofit, the province of Bozen can be characterized as a highly regulated territorial system revolving around the knowledge and cultural leadership developed by the provincial energy certification agency, Casaclima, by many considered the most relevant national initiative in environmentally sustainable building (Marrone, 2017). Since 2014 Casaclima has been the Agency for energy and climate issues for the Province of Bozen, further embedding its expertise in the territorial institutional system.

The Casaclima certification distinguishes itself from other certifications because it is based upon a strict calculation protocol and a control over the whole process of building - from the project to the building site to the finished building (Marrone, 2017). Moreover, it stands out for the particular attention paid to the intervention on the entire building envelope, aimed at pursuing the goal of energy efficiency through the improvement of global thermal insulation. Casaclima also configures a structured and organized territorial supply chain based on a network of small businesses and professionals.

The municipality of Bolzano has combined this territorialized expertise with a strict building regulation system. In 2007 it introduced the obligation to meet the Casaclima B standard (equivalent to an energy requirement of less than 50 kWh/m^{2}a per year) in new buildings and also in those that envisage a renovation of at least 50% of the surface area.

While this model proved successful in promoting retrofit in rural areas, it encountered several difficulties in the urban area of Bozen. In the city, which also distinguishes itself from the rest of the region for the spatial concentration of Italian-speakers, the buildings are older and often consist of multi-family dwellings.

In order to overcome the inertia of the urban area, volumetric incentives have recently been added to the above regulatory instruments, linking energy certification to the possibility to expand the building surface.

However, the results of the use of the tool of volumetric incentives, which aims at using the real estate market as a lever of change, are ambivalent. While the instrument has proved successful in a few cases of condominiums where it was possible to sell the attics once used as accommodation for the servants (Magnani, 2015), data from Casaclima for the period between 2011 and 2017 show a significant decrease of retrofitting using this incentive. This highlights that building anew, even in a high-density focused way, is rarely a winning strategy for environmental change, especially in a situation of scant availability of additional building space and a stagnant real estate market.

The municipality of Bolzano has also sought to promote private retrofit processes through participation in European projects and initiatives, but with little success.[2] This is the case of the EPOurban project (Enabling private owners of residential buildings to integrate them into urban restructuring processes). Within this project a commission of transversal technicians was set up. It comprised an engineer, an architect, and a legal expert who could offer free advice to condominiums interested in receiving a study that considered the different possibilities of energy redevelopment. Among the buildings proposed have been condominiums in different parts of the city and with very varied features, from building under protection as monuments to buildings of different historical periods (the1980s/1970s) and of different sizes (larger and smaller). The study is delivered to the condominium with all the possibilities of retrofit to be activated.

Eventually, by the end of the project not one of the flats involved had

[2] Concerning the public building sector, the Municipality of Bolzano has been involved in the Sinfonia project (Smart initiatives of cities fully committed to investing in advanced large-scale energy solutions), which provides for the redevelopment and certification in CasaClima A of about 300 of the 700 municipal housing units existing in the Municipality (Mosannenzadeh et al., 2017).

undertaken the suggested retrofitting. In 2017, in the attempt to push the energy transition further, especially in the urban area, a contribution of 70% non-repayable to condominiums with at least 5 floors only for building insulation (coat/roofs/floors) has been approved.

At the end of 2017 due to the limited results of all these measures and to the growing recognition of the social barriers and not just economic obstacles to the undertaking of retrofitting, a different step was taken. A working group was created with the goal of bringing together diverse actors - municipalities, the province, regional research centres (Eurac), the institute for social housing (Ipes), the association of buildings administrators (Anaci), banks, and environmental associations (Legambiente) - in order to work out common solutions to push energy efficiency initiatives.

In conclusion, as reported by Table 5 the case of Bozen thus reveals a situation where a social block can be identified among local institutions, market actors and civil society actors (including mainly small enterprises), also due to the fact that technological paths are more certain and uniform thanks to the institutional embedding of the local certification agency. Compared to the case of Alessandria we can highlight a so-called 'intermediation development', where the path dependence based on project chain is overcome and there is a more composite situation with growing interdependence among local actors also thanks to organizational learning processes.

6.3. *The case of Padua*

The city of Padua has stood out for its commitment to promoting sustainable urban policies. It was among the first municipalities in Italy to adopt a Local Agenda 21, the implementation of an environmental accounting system, the introduction of Green public procurement (GPP), the enhancement of sustainable mobility (Mascia, 2015).

As regards the energy sector, since the 2000s the municipality of Padua has developed a number of planning measures in pursuit of the goal of reducing climate-related emissions. As early as 2004 with the Energy Efficiency Plan it launched an initial analysis and evaluation of the most "energy-intensive" sectors of the public administration. In 2009 with the Energy Operational Plan the administration started the implementation of actions aimed at improving the performance of its offices and services. In 2011 the municipality joined the Covenant of Mayors aiming at a 20% reduction in greenhouse gas emissions.

In the implementation of the commitments foreseen in these plans the Municipality of Padua has focused on the promotion of renewable energy production, especially photovoltaic and solar thermal energy installations on visible surfaces of public buildings (school buildings, sports facilities, car parks, stadium stands etc.), where there is also a symbolic value of the intervention (Mascia, 2015).

As regards private buildings, in 2010 the municipal administration promoted "Padua Solar", an initiative to encourage and facilitate the installation of photovoltaic systems through the involvement of a group of producers in the sector and some banks guaranteeing zero interest loans. In addition, the Municipality has promoted, in collaboration with the environmental association Legambiente, the establishment of expert-supported PV collective purchasing groups with the goal of obtaining lower prices for the purchase and installation of renewable energies plants.

These interventions, on which the administration's efforts first focused, were perceived as easier than the retrofit of buildings in a period of scarcity of resources.

As in the case of Alessandria, the impetus to start addressing the retrofit issue has recently derived from participation in a EU-funded project, namely "Padua Fit". The general target of the project was the retrofitting of 200 condominiums in the urban area of Padua.

In particular the project's main innovative result was the formation of a group of *condominium facilitators* with the specific task of assisting administrators in the difficult task of accompanying property owners in the decision to implement the retrofit intervention.

The condominium facilitator is a new professional figure who combines technical expertise concerning the themes of energy requalification of buildings with the ability to accompany the administrator and the condominium assembly through the complex decision-making process required for energy upgrading.

The project moved through the following steps. A preliminary audit with data collection of energy consumption and profile of the building was carried out free of charge. Next, the data were processed by the technical partners, producing an estimate of costs, energy savings and time for investments return. Then a meeting between the facilitator, the condominium assembly and the condominium administrator was organized where the building's actual energy conditions, the opportunities and advantages of the interventions were presented. Eventually, a second meeting was possible for in-depth analysis of technical-financial aspects. Following the selection process, the condominium received a commercial offer from an ESCo Company.

Indeed, another key innovative aspect of the project was the involvement of local businesses, in particular local ESCos, through a public tender where the municipal administration played a key role of guarantor of the overall procedure.

At the national level this is the first time that a public tender for an Energy Performance contract for interventions in private buildings has been adopted (usually ESCo companies stipulate retrofit contracts directly with single households or organizations). In the public tender, particular attention has been given by the Padua municipality to the involvement of local companies and companies using ecological means of transport.

The purpose of this intermediation of the public actor is to support people who do not know technical aspects for energy performance contracts by facilitating the identification of trustable private companies and ensuring the quality of their intervention.

By the end of the project, 69 audits had been carried out on "facilitated" buildings, 33 of these expressed adherence to the project, in 22 cases estimates were produced by the ESCo and 5 contracts for energy retrofit were signed.

Eventually, through public campaigns, seminars and events, condominium assemblies and individual meetings the project was also an opportunity to significantly increase the knowledge of citizens about the issues of energy and Energy Performance Contracts and Guarantees.

As it emerges from Table 5 among the cases considered here the city of Padua presents a situation characterized by more dispersed actors. However, the situation is not static because recently, through the lever of EU-funding, attempts have begun to create new forms of intermediation between demand and supply - trying to involve proactively especially Citizens and Condominial Assemblies, Condominium Administrators and their associations, Associations of (small) owners, Unions of owners and tenants.

7. Conclusion and policy implications

The Italian case at both national and local level shows that buildings eco-retrofit has not been a turning point of urban development. After the period of great growth of suburban residential units, and infrastructures, especially ring roads and high-speed railway stations, there was not a period of general ecological renovation. The opportunity to equip construction companies with new knowledge was not seized, even though energy saving and urban green regeneration were frequently mentioned in discourses and policies.

The reasons for the missed opportunity are several. The uncertainty of retrofit investment return has played an important role. Moreover, the plurality of techniques provided by the market for the insulation of buildings discouraged many companies.

Some other reasons concern the demand side. From national research as well the three case studies it emerges a quite passive and segmented role played by inhabitants. Retrofit has never been a bottom-up movement, a self-construction activity, but rather a top-down initiative. To

the income problems of many, especially during the economic crisis, one must add the intricacy of administrative procedures for works authorization and for activating the fiscal detraction.

As we have seen, an obstacle on the demand side is also the need for agreement on retrofit among the condominium residents. This is problematic especially for insulation that requires - for technical and aesthetic reasons - uniform work on walls and the roof. The disagreement is created not only by the mentioned uncertainties but also by the precarious socio-economic conditions of many residents in the condominium. The regressive role played by the fiscal detraction – more advantages for richer peoples – has been demonstrated.

The research has shown that progress in the eco-retrofit of buildings depends mainly on intermediators. In the case studies, their role emerges clearly; most frequently they are public official or semi-public agencies. In Alessandria the municipal urban planning service started the long series of projects that collected important institutions and grants. In Bozen the certification society CasaClima exercises an original and strategic influence in all the building sector. It is a Province owned agency, which was able however to become leader at the national level.

In Padua the role of strong intermediators is less evident. Difficulties in engaging the condominium manager associations were found also for obtaining information. They recognised the importance of the retrofit issue, but they were discouraged for the reasons mentioned above. Stronger intermediators emerged only 'within' the projects. As a result they are strictly linked to EU projects' logic: creation of a temporary network of actors, achievement of external rewards, limited duration, experimental or demonstrative nature. This kind of intermediation risks supporting the great number of experts that move from one project to another rather than the retrofit investments themselves. For this set of reasons Padua has not been placed in the position of strong intermediators (Table 5). Intermediators in the case of Padua are many and small; some of them belong to the non-profit sector. Probably they are not big enough to pilot construction industry and aggregate unruly residents of condominiums.

However, this does not diminish the importance of focusing on intermediators. They perform crucial roles in an urban panorama that has become inevitably polycentric (Hall and Pain, 2006). Probably, they must be coupled with financial intermediators available to move 'patient capital', that is, capital with low rate and long term return (Apgar, 2015; Pendall et al. 2012). Thus, the paper results highlight the need for engaged (or no-profit) intermediaries able to acquire new knowledge on retrofit technologies, to instill trustfulness in companies and inhabitants, and mobilize patient capitals, especially given that EU projects or fiscal detractions will inevitably finish. Nevertheless, the availability of large-scale funds and measures is a basic condition for creating those local consortia engaged in buildings eco-retrofit. That ultimately justifies the combination of socio-spatial analysis with urban actors perspective.

Author contribution statement

Natalia Magnani, Giovanni Carrosio, Giorgio Osti: Conceptualization; Giovanni Carrosio: Data curation; Natalia Magnani, Giovanni Carrosio, Giorgio Osti: Formal analysis; Investigation; Methodology; Natalia Magnani: Writing - original draft; Natalia Magnani, Giorgio Osti: Writing - review & editing

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Apgar, S., 2015. Patient capital for new communities. Urban Land, June 22. Available at: https://urbanland.uli.org/development-business/patient-capital-new-communities/. (Accessed 12 November 2018).

Bird, C., Barnes, J., 2014. Scaling up community activism: the role of intermediaries in collective approaches to community energy. People Place Pol. Online 8 (3).

Bulkeley, H., Edwards, G.A., Fuller, S., 2014. Contesting climate justice in the city: examining politics and practice in urban climate change experiments. Global Environ. Change 25, 31–40.

Burt, R.S., 1992. Structural Holes: the Social Structure of Competition. Harvard University Press, Cambridge, Mass.

Caputo, P., Pasetti, G., 2015. Overcoming the inertia of building energy retrofit at municipal level: the Italian challenge. Sustain. Cities Soc. 15, 120–134.

Carrosio, G., 2015. Politiche e campi organizzativi della riqualificazione energetica degli edifici. Sociol. Urbana Rurale 106, 21–44.

Conticelli, E., Proli, S., Tondelli, S., 2017. Integrating energy efficiency and urban densification policies: two Italian case studies. Energy Build. 155, 308–323.

Copiello, S., Bonifaci, P., 2015. Green housing: toward a new energy efficiency paradox? Cities 49, 76–87.

Cresme, 2017. Il recupero e la riqualificazione energetica del patrimonio edilizio: una stima dell'impatto delle misure di incentivazione. Available at: http://documenti.camera.it/leg17/dossier/pdf/Am0051d.pdf.

Davies, M., Oreszczynn, T., 2012. The unintended consequences of decarbonising the built environment: a UK case study. Energy Build. 46, 80–85.

De Wilde, M., Spaargaren, G., 2018. Designing trust: how strategic intermediaries choreograph homeowners' low-carbon retrofit experience. Build. Res. Inf. 1–13.

Della Porta, D., 2006. La Politica Locale. Il Mulino, Bologna.

Enea, 2018. Energy Efficiency Trends and Policies in Italy. Rome, July.

Goulder, L.H., Parry, I.W., 2008. Instrument choice in environmental policy. Rev. Environ. Econ. Pol. 2 (2), 152–174.

Grandclément, C., Karvonen, A., Guy, S., 2015. Negotiating comfort in low energy housing: the politics of intermediation. Energy Pol. 84, 213–222.

Granovetter, M.S., 1982. The strength of weak ties. Am. J. Sociol. 78 (6), 1360–1380.

Greening, A.L., Greene, D.L., Difiglio, C., 2000. Energy efficiency and consumption – the rebound effect - a survey. Energy Pol. 6–7, 389–401.

Guy, S., Marvin, S., Medd, W. (Eds.), 2011. Shaping Urban Infrastructures: Intermediaries and the Governance of Socio-Technical Networks. Routledge, London.

Hall, P.K., Pain (Eds.), 2006. The Polycentric Metropolis: Learning from Mega-City Regions in Europe, London. Routledge.

Hargreaves, T., Hielscher, S., Seyfang, G., Smith, A., 2013. Grassroots innovations in community energy: the role of intermediaries in niche development. Global Environ. Change 23 (5), 868–880.

Kivimaa, P., 2014. Government-affiliated intermediary organisations as actors in system-level transitions. Res. Pol. 43 (8), 1370–1380.

Magnani, N., 2015. Politiche, agenzie e pratiche di retrofit energetico nella città. Il caso di Bolzano. Sociol. Urbana Rurale 106, 57–69.

Maller, C.J., Horne, R.E., Dalton, T., 2011. Green renovations: intersections of daily routines, housing aspirations and narratives of environmental sustainability. Hous. Theor. Soc. 3, 255–275.

Marrone, V., 2017. La costruzione sociale dell'efficienza energetica. Un approccio sistemico a CasaClima. Sociol. Urbana Rurale 114, 95–112.

Mascia, M., 2015. Politiche per l'energia e lo sviluppo delle fonti rinnovabili. Il caso di Padova. Sociol. Urbana Rurale 106, 45–56.

Mosannenzadeh, F., Bisello, A., Diamantini, C., Stellin, G., Vettorato, D., 2017. A case-based learning methodology to predict barriers to implementation of smart and sustainable urban energy projects. Cities 60, 28–36.

Moss, T., 2009. Intermediaries and the governance of sociotechnical networks in transition. Environ. Plann. 41 (6), 1480–1495.

Osti, G., 2015. Energia e urbanizzazione: un gioco nuovo ed incerto. Sociol. Urbana Rurale 106, 7–20.

Pelenur, M., Cruickshank, H.J., 2012. Closing the Energy Efficiency Gap: a study linking demographics with barriers to adopting energy efficiency measures in the home. Energy 1, 348–357.

Pendall, R., Gainsborough, J., Lowe, K., Nguyen, M., 2012. Bringing equity to transit-oriented development: stations, systems, and regional resilience. In: Weir, M., Pindus, N., Wial, H., Wolman, H. (Eds.), Urban and Regional Policy and its Effects: Building Resilient Regions. Brookings Institution Press, pp. 148–191.

Powell, W.W., 1990. Neither market nor hierarchy: network forms of organization. In: Staw, B.M., Cummints, L.L. (Eds.), Research in Organizational Behavior, vol. 12. CT JAI Press, Greenwich, pp. 295–336.

Rohracher, H., 2009. Intermediaries and the governance of choice: the case of green electricity labelling. Environ. Plann. 41 (8), 2014–2028.

van Lente, H., Hekkert, M., Smits, R., van Waveren, B., 2003. Roles of systemic intermediaries in transition processes. Int. J. Innovat. Manag. 7, 247–279, 03.

Vergragt, P.J., Halina, S.B., 2012. The Challenge of Energy Retrofitting the Residential Housing Stock: Grassroots Innovations and Socio-Technical System Change in Worcester. Technology Analysis and Strategic Management, MA, pp. 407–420.

Verones, S., Zanon, B. (Eds.), 2012. Energia e pianificazione urbanistica. Verso un'integrazione delle politiche urbane. FrancoAngeli, Milano.

Virkki-Hatakka, T., Luoranen, M., Ikävalko, M., 2013. Differences in perception: how the experts look at energy efficiency (findings from a Finnish survey). Energy Pol. 60, 499–508.
Warbroek, B., Hoppe, T., Coenen, F., Bressers, H., 2018. The role of intermediaries in supporting local low-carbon energy initiatives. Sustainability 10 (7), 2450.
Wilson, C., Crane, L., Chryssochoidis, G., 2015. Why do homeowners renovate energy efficiently? Contrasting perspectives and implications for policy. Energy Res. Soc. Sci. 7, 12–22.