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ENERGY RETROFIT: A REVIEW OF TRANSDISCIPLINARY APPROACHES

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Abstract

The purpose of this paper, which reports work that has been undertaken as part of a H2020 Marie Skłodowska-Curie project, is to examine the transdisciplinary (multidisciplinary and interdisciplinary) practices in energy retrofit in the UK. Energy retrofit is defined as the refurbishment of existing buildings to reduce their energy demand. Currently, it is recognized as a relevant strategy to improve the environmental and energy qualities of buildings and cities. Nevertheless, its full potential cannot, at present, be exploited due to lack of integration among disciplines. This disintegration is considered to be one of the key reasons behind the performance gap between the design aspirations and performance in use. A literature review was conducted through a qualitative approach to evaluate the state-of-the-art in transdisciplinary practices and to identify emerging lines of inquiry in Energy Retrofit. The findings are presented as a novel conceptual framework, which illustrates the need to develop capabilities to manage the complexity inherent in these projects. Future steps, which seek to move from a conceptual framework to an integrated learning platform, are also presented. This platform will be exploited by built environment professionals for deep energy retrofit as a step towards managing complexity.

Keywords

Transdisciplinary Approaches, Deep Energy Retrofit, Knowledge Management, Knowledge Transfer

1 Introduction

Energy Retrofit (ER) concept plays an important role in the transition to low carbon cities, because buildings make a substantial contribution to the total energy demand. In an analysis of UK emissions, Boardman [1] reported that buildings accounted for 18% of greenhouse gas (GHG) emissions in 2015, with 75% of this share attributable to residences, 15% to commercial buildings and 10% to public sector buildings. Additionally, in another major study the Committee on Climate Change [2] showed that over two thirds of the buildings that will exist in the UK in 2050 have already been built and, in particular, over three quarters of the 28 million dwellings in the UK were built before 1980. It is thus clear that the existing energy-intensive building stock needs to be upgraded to high performance buildings for success in the long-term reduction of energy demand and of the related GHG emissions [11]. Furthermore, the low carbon cities transition discourse acknowledges the need for developing a transdisciplinary approach to ER, by advocating collaborative and interactive research [14], in order to close the performance gap between the design aspirations and performance in use [3]. Here, the term "transdisciplinary" refers to both multidisciplinary and interdisciplinary approaches [8]. It requires the stakeholders and experts, who take part in mutual and joint learning processes, to develop new cognitive skills and habits [14].

Several studies have examined transdisciplinarity in Energy Retrofit, and suggested new integrative processes to holistically evaluate a multitude of technical and non-technical factors. For example, Ma et al. [9] state that a plethora of retrofit technologies are available. They acknowledge the challenge in terms of assessing the appropriateness of different technological solutions to different problems in different scenarios. They propose the following criteria are used in making this assessment: 1) the desired reduction in heating and cooling demand, 2) user-technology match, 3) efficiency of the system; and 4) adoption of low energy technologies, renewable energy technologies and electrical system retrofits. Dixon et al. [4] explored the evolution of the retrofit concept, and its manifestation at multiple socio-technical levels, i.e. building, neighbourhood, city-regions, and domains, i.e. energy, water, use of resources. They suggested the concept of Urban Retrofit as a means to delivering the transition to low carbon cities. Hong et al. [5] draw our attention to the impact of human behaviour on building technologies and operation as a specific aspect of energy retrofit. They identified four components that need to be integrated into the energy modelling process: the drivers of behaviour, the needs of the occupants, the actions carried out by the occupants, and the building systems used by the occupants. Moreover, they consider this integration relevant in order to reduce the performance gap between predicted energy performance of buildings and actual measured energy use once buildings are operational. Jagarajan et al. [7] investigated how the concept of green retrofitting plays a pivotal role in reducing the environmental impact of existing buildings and not just reducing energy demand. They developed a conceptual framework which identified the challenges in 'green retrofit'.

Together, these studies have pointed out that initially, the ER concept has been mainly related to technical issues (i.e. considering building insulation and financial assistance strategies and building energy demand). Then, its transdisciplinary nature in terms of providing socio-technical solutions, which take into account energy, environmental and social impacts of retrofitting strategies at scale, emerged. However, considerable uncertainty still exists regarding the relationships between ER and transdisciplinary approaches, because such relationships require the involvement of a wide range of actors who are encouraged to engage in deep, integrative interactions. These actors need to develop and operationalise the necessary knowledge and skills for these interactions to be enacted [6].

The reviewed literature characterises the transdisciplinary research on ER. These prior studies suggest the importance of transdisciplinary approaches in ER. Moreover, they stress the need for stronger interactions among disciplines. Nevertheless, the problem of both activating these integrative ER interactions and developing the required knowledge in a meaningful and structured way, remains unresolved. Consequently, transdisciplinary approaches emerge as fragmented experiences and the significance of the integrated ER process is not adequately highlighted. Furthermore, a transdisciplinary conceptual framework for ER has not yet been developed.

This paper seeks to close these gaps by analysing the literature on transdisciplinary approaches to ER within the UK context. The central question is the significance of an integrated process in the context of ER projects; and the way this process can be managed. The investigation and analysis reported in this paper were undertaken as part of a broader set of activities to promote knowledge integration in Energy Retrofit. The research programme structure is shown in Figure 1.

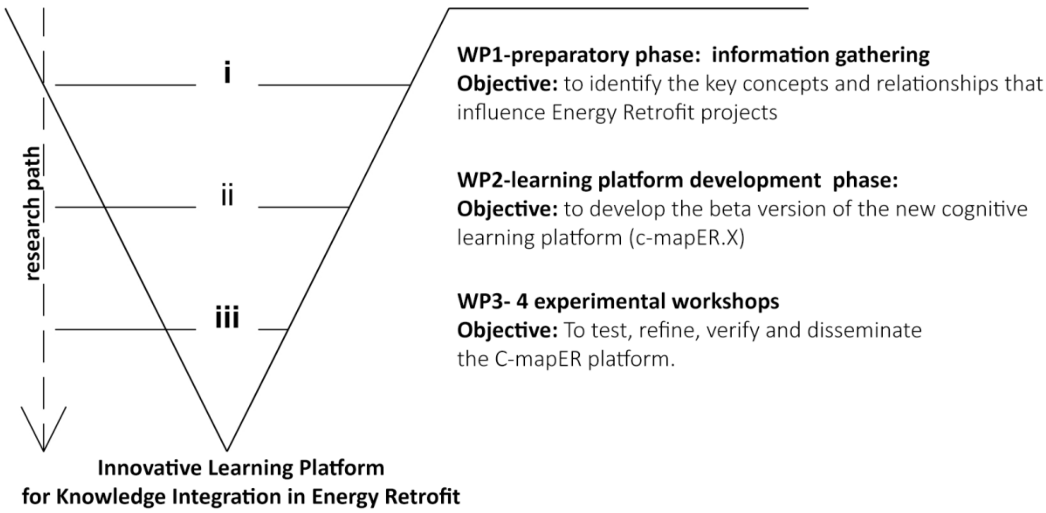

Figure 1. The structure of the research

This paper reports the progress in WP1, which aims at identifying key concepts that influence Energy Retrofit projects. It underlines the development of a conceptual framework on Transdisciplinary Energy Retrofit (TERCF).

It is organized as follows. The next section first introduces the preliminary version of the TERCF, and then discusses the methodological approach. Section 3, illustrates how the identified themes were integrated to elaborate on the TERCF. The final section discusses the significance of the integration in the context of ER projects and presents the next phase of the research.

2 Methodology

Grounded Theory was adopted to identify specific transdisciplinary themes in the literature. This literature review was conducted in two phases. In the second phase, which is the focus of this paper, Grounded Theory was combined with cognitive mapping. In both phases, data collection and analysis continued until theoretical saturation had been achieved, following Marying's [10] qualitative approach. The researcher continued to code the data until no new categories could be identified and until new instances of variation for existing categories had ceased to emerge [12]. In some instances categories were modified or changes in perspective occurred as the Grounded Theory approach was implemented [12].

In the first phase, 136 peer-reviewed journal papers were selected for content analysis. This content analysis followed an inductive approach. An initial conceptual framework on Transdisciplinary Energy Retrofit (TERCF), which is characterised by 5 categories, 15 lines of research and 50 main concepts, was thus developed and paved the way for this paper. The results from the first phase of the analysis are shown in Figure 2.

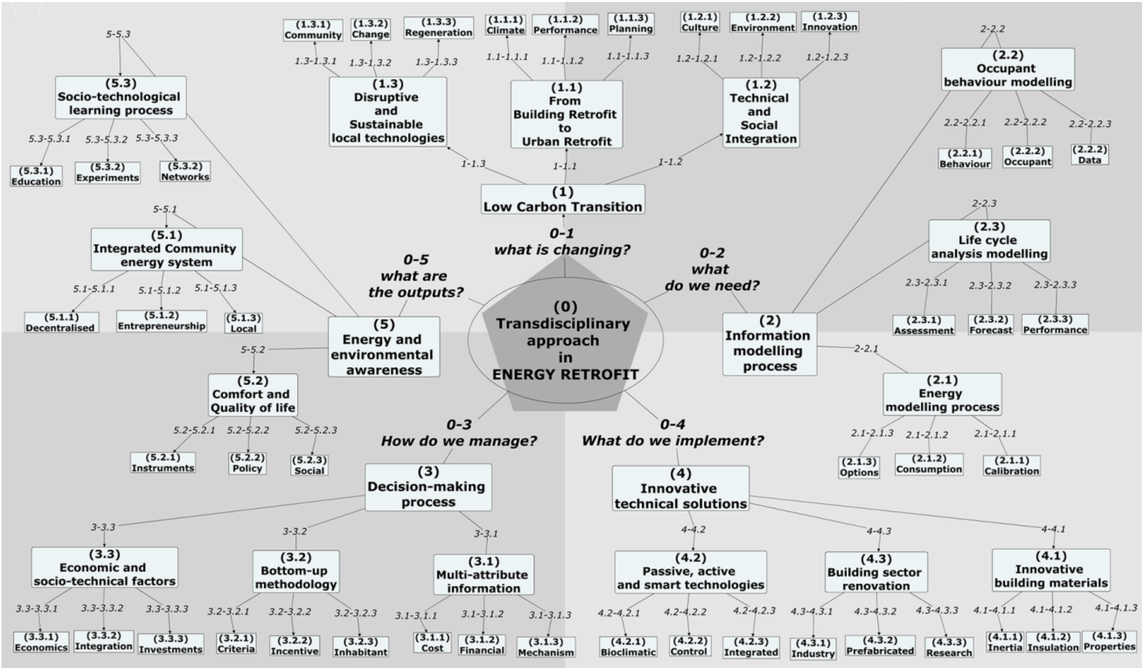

Figure 2. Transdisciplinary ER Conceptual Framework developed in a prior phase.

The following criteria were used to select the papers for analysis in the second phase. The first set of selection criteria was that papers studied multidisciplinary and interdisciplinary practices in Energy Retrofit. They were peer-reviewed and published in prominent journals. The second set of selection criteria was that papers:

- were published between January 2014 and December 2017; and
- mainly focussed on empirical experiences in the UK.

The publication period meant that the selected papers represented current examples in terms of energy policies, innovation technologies and social issues. Only UK examples were selected so that they were relevant to the UK-based workshop participants who will take part in the final step of this research. These selection criteria yielded 77 journal papers (Annex 1).

Descriptive data was generated for every paper. Coding facilitated the identification of patterns and allocation of concepts to the existing lines of research. A deductive approach to coding was adopted. The new set of data was analysed in relation to the existing cognitive structure represented by the initial TERCF before introducing new categories. NVIVO was used to conduct word frequency and pattern analyses. Once categories and lines of research were determined, patterns were integrated using cognitive mapping [12], which enabled the comparison and re-organisation of the concepts. Finally, the integrated themes were incorporated into the TERCF.

3 Results

Table 1 provides the results that the above process yielded. It illustrates how the themes identified (Annex 2) were integrated.

Summary, put in hierarchy order at two level, the most general and inclusive concepts were positioned at the first level (e.g. to re-engineer systemically their built environment and urban infrastructure in response; to combine effects of mitigation and adaptation measures), the more specific and exclusive concepts arranged hierarchically below (e.g to climate change and resource constraints; to adapt suburbs physically to mitigate against further climate change and to adapt to inevitable weather patterns; to integrate retrofit and governing). The integration process involved only the first level; while the second level will be articulated and integrated in the final structure of the TERCF.

Table 1: Trans-disciplinary Conceptual Framework on Energy Retrofit

Code	Integrated themes	Source (ANNEX 1)
01.1	To re-engineer built environment and urban infrastructure and combine effects of mitigation and adaptation measures	[13]; [58]; [76]; [12]; [73]; [69]; [34]
01.2	To describe drivers and barriers and sociological implications to the adoption of sustainable retrofit measures	[65]; [68]; [32]; [39]; [1]; [57]; [64]; [42]; [2]
01.3	To explore community-based energy retrofits for the practical realisation of the smart city imaginary	[70]; [27]; [67]; [61]
02.1	To integrate knowledge to an appropriate level in order to assess the impact of a diverse range of retrofit measures	[53]; [6]; [55]; [38]; [62]; [46]; [17]; [77]; [50]; [37]
02.2	To investigate on the relationship between buildings and people through a process of interactive adaptation' and co-evolution of the physical and the social factors	[29]; [7]; [41]; [15]; [44];[47]; [52]; [59]; [45];
02.3	To integrate life cycle energy and environmental performance	[31]; [28]; [3]
03.1	To reduce the level of uncertainties taking into account the multi-benefit of retrofit measures.	[4]; [36]; [35]; [24]; [16]; [23]; [40]
03.2	To follow a multi-stage development process to improve local green building features	[18]; [5]
03.3	To pursue social justice reducing fuel poverty and promote innovative financial mechanism	[71]; [26]; [30]; [19]; [74]
04.1	To assess the performance and the environmental impacts of life cycle insulation	[9]; [11]; [8]
04.2	To define and preserve the building envelope features	[43]; [21]; [75]; [22]
04.3	To consider the level of knowledge of local micro-enterprises and stakeholders' perspective when sustainable energy technologies are promoted.	[10]; [54]; [51]; [25]
05.1	To pursue more socially transformative pathways to sustainability involving community organisations	[60]; [14]; [56]; [72]; [63]; [33]

05.2	To analyse different technologies that have been adopted and their perceived effectiveness.	[65]; [49]; [20]
05.3	To improve the participatory process taking into account practitioners and academic perspectives	[48]

A number of significant aspects of Energy Retrofit in the UK emerged. First of all, transdisciplinary approaches recurred throughout the dataset. No new lines of research were identified. Hence, at the moment, the TERCF saturation is validated. However, it is apparent from the data, that the distribution of papers among the existing lines of research is not homogenous. Consequently, our findings suggest a hierarchy among the themes which are investigated in UK.

In addition, the results obtained from the second phase of the analysis allowed us to refine the lines of research in the original TERCF. What is interesting in this data is that the integrated themes provide an objective for each line of research (e.g. each line of research is articulated starting from a verb, which introduces a scope providing details about the concept arranged hierarchically below). The results that were integrated into the original TERCF cognitive structure is shown Figure 3.

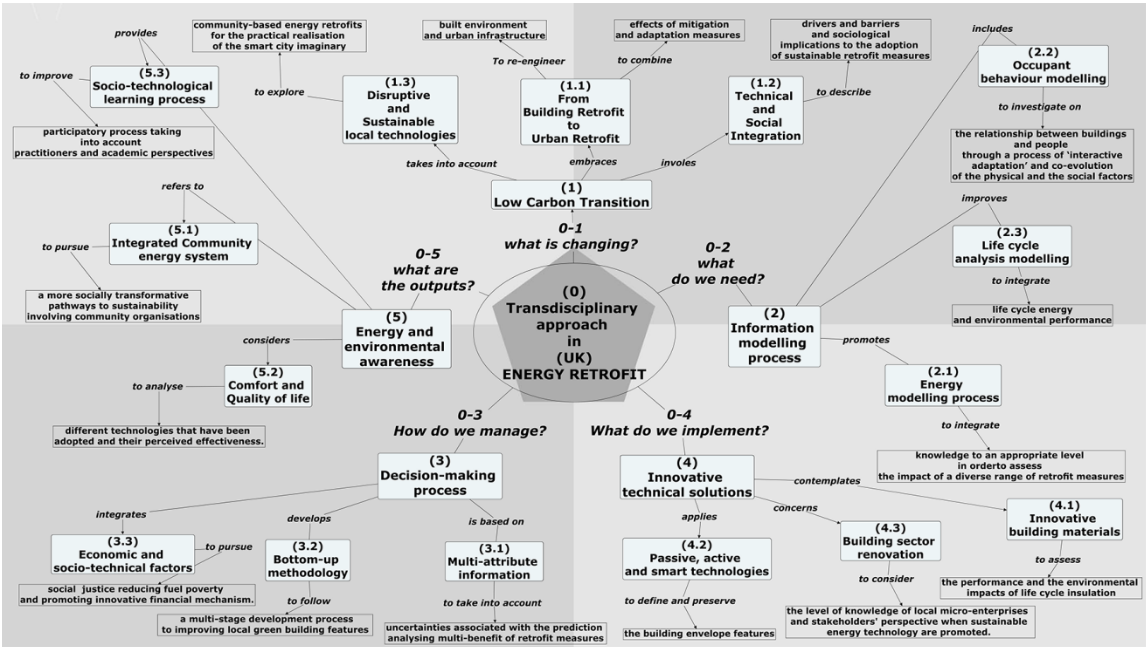

Figure 3. Transdisciplinary ER Conceptual Framework combined with integrated themes.

The relationships among the concepts began to be clarified through the second phase of the analysis. The integrated themes were articulated as concepts and linking phrases, following the principles of cognitive mapping (Figure 3). It is argued that cognitive maps are more likely to trigger connections between the results and the user's prior knowledge than the representation of data in the traditional text form (see Table 1 as an example). It could be argued that the users' are passive consumers of textual information presented in Table 1 and they are more likely to interact with the information presented as a cognitive map (Figure 3). User feedback will be collected as part of the workshops, which will run during the last phase of this research, in order to test these assumptions.

4 Discussion

The discussion focusses on the research question regarding the significance of integration in ER projects and how the process of this integration can be managed. This study identified 15 Integrated Themes concerning transdisciplinarity in ER in the UK. The most interesting finding was that the development of knowledge transfer strategies among actors emerges as a main component in integration. This component is clearly traceable in Table 1, and in particular, in the following Integrated Themes: 01.3, 02.1, 02.2, 03.1, 03.3, 04.3, 05.1, 05.2, and 05.3.

Therefore, these results are in agreement with Hope's findings [7], indeed they emphasize the need for discussing the role of knowledge creation, exchange and transfer in order to develop innovative approaches to deal with sustainability challenges. Hope [6] describes the transdisciplinary approach as one that transcends traditional disciplinary boundaries, and that disciplinary integrations involve interactions between actors and institutions which have different approaches and scopes. Furthermore, these interactions require the re-orientation of the research agenda, which has to be conducted in a multi-stakeholder environment to address complex societal problems that require a multidisciplinary approach [13 quoted in 6]. Therefore, Hope [6] proposed a conceptual framework for knowledge exchange in sustainable development which was based on specific attributes and well-structured mechanisms. The attributes were: "transdisciplinarity, participatory, problem-oriented, practice-oriented, formal and informal interactions, networked" [6, p. 801]. Hope [6] explains that many attributes can be combined through mechanisms such as knowledge transfer partnerships.

The findings of this study provide further contribution to the discourse on how knowledge transfer partnerships can be improved. They concur the significance of integrated processes in the context of transdisciplinary ER projects. Conceptual frameworks, which are not just limited to describing the pre-requisites for integration, are suggested as tools for facilitating integration through the development of new cognitive skills, i.e. the ability to observe, manipulate, articulate and discuss how concepts and relationships interact in multidisciplinary contexts. It is argued that traditional conceptual frameworks could be inadequate for this new scope, because they are mainly used to describe findings rather enabling users to interact with it.

Comparison of the TERCF with previously developed conceptual frameworks provides encouraging insights. For example, Jagarajan et al. [9] and Ma et al. [6] elaborated two innovative ER conceptual frameworks. Jagarajan et al. [9] suggested the concept of green retrofitting, while Ma et al. [6] explored key influences on building retrofit. These studies have provided a considerable contribution towards clarifying the issues concerning transdisciplinarity in ER projects by developing conceptual frameworks which comprise of innovative categories and concepts. On the one hand, this study confirms that working on categories and concepts can be considered to be a useful approach to introduce advanced concepts. On the other hand, the findings show that categories and concepts on their own do not facilitate integrated approaches, which are substantially based on the relationships rather than categories and concepts themselves.

This study provides such a cognitive apparatus, which is focused on specific themes of integration in ER. This apparatus can be adapted and modified with regard to specific topics and contexts through the combined use of the ground theory method and mapping technique, has been provided in this paper. The users are called to interact with this apparatus, through cognitive mapping as a dedicated learning procedure. The finalisation of the cognitive maps by the users enables the improvement of their cognitive skills and the development of meaningful ER discourses. The integrated themes are incorporated into the TERCF as a sequence of relationships. Here, the aim is to facilitate the integration of different points of view and different levels of prior knowledge, which is a determinant of the level of knowledge transfer in transdisciplinary contexts.

Finally, the research findings may contribute to the development of an instructional design tool, which facilitates the integration of transdisciplinary knowledge in ER in meaningful ways. This approach may also be considered as good practice aimed at preparing qualified graduates for their respective professions by addressing the various obstacles to the implementation of transdisciplinary curricula which focusses on the concept of ER as a means to delivering low carbon cities.

5 Conclusion and perspectives

The purpose of this study was to determine the significance of an integrated design and delivery in ER projects. Specifically, this study has shown that the cognitive structure of the Transdisciplinary Energy Retrofit Conceptual Framework can be adapted to suit specific contexts, revealing a preliminary set of meaningful relationships. The results of this study support the idea that there is a need for innovate learning methods and tools in order to facilitate the integrated process. Although this study has successfully demonstrated that the combined use of the grounded theory and cognitive mapping offers an effective way to develop a learning apparatus, this process has not yet been completed. A natural progression of this work is to define all the relationships among the concepts proposed in the TERCF. The next step is to transfer the final version of the TERCF into a computer environment using the IHM Concept Map Software and to prepare the instructions for using the Learning Platform according to different levels of prior knowledge. Finally, the platform will be tested in four experimental interdisciplinary workshops, which will be dedicated to researchers, undergraduate and post-graduate students and practitioners. Feedback from these experimental experiences will be useful to improve the learning tool. The emergent tool has the potential to be adopted to undergraduate and postgraduate higher educational programmes.

Acknowledgements

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ANNEX 1 –Literature review: list of references

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ANNEX 2 – Identification of relevant ER patterns and their hierarchy

Cod	1-LOW CARBON TRANSITION:	
	Patterns and hierarchy*	**Source (ANNEX 1)**
01.1	**I level (inclusive patterns:** to re-engineer systemically their built environment and urban infrastructure in response to combine effects of mitigation and adaptation measures **II level (detailed patterns):** to climate change and resource constraints; to adapt suburbs physically to mitigate against further climate change and to adapt to inevitable weather patterns; to integrate retrofit and governing; to promote systematic reconfiguration of socio-technologies of energy in the existing built environment and infrastructure; to link the energy-reducing and energy-increasing effects of urban morphology characteristics in 'place-specific' neighbourhoods; to analyse the scale of rebound effects of energy retrofit measure; to drive change in urban energy systems.	Eames et al., 2013; Rydin et al., 2013; Williams et al., 2013; Dixon et al., 2014; Webber et al., 2015; Urquizo et al., 2017; Hodson and Marvin, 2017.
01.2	**I level (inclusive patterns:** to describe drivers and barriers to the adoption of sustainable retrofit to consider the sociological implications about housing energy retrofit **II level (detailed patterns):** to encourage the use of renewable energy for electricity generation; to balance thermal issues against a range of heritage and aesthetic concerns; to identify the range of factors that influence domestic energy consumption; to support the local economy; to explore the role energy co-operatives; to analyse the core characteristics of the ESCo model; to install renewable micro-generation energy sources; to assess the compatibility between renewable systems and aesthetics and significance of historic buildings; to define energy system stakeholders and community-based partnerships	Swan et al., 2013; Tham and Muneer, 2013; Hannon et al., 2013; Karvonen, 2013; Agbota et al., 2014; Reid et al., 2015; Sunikka-Blank and Galvin, 2016; Li et al., 2016; Ambrose et al., 2017
01.3	**I level (inclusive patterns:** to explore opportunities and tensions in the practical realisation of the smart city imaginary to improve city-scale retrofit and community-based energy retrofits **II level (detailed patterns):** to investigate on the capacity of urban governments to control their infrastructural destiny; to reduce the gap between intent and outcome; to analyse uncertainties in the wind and solar generation; to consider carbon capture and storage (CCS) technologies	Watson et al., 2014; Gupta et al., 2015; Taylor Buck and While, 2017; Sharifzadeh et al., 2017
Cod	**2-INFORMATION MODELLING PROCESS:**	
	Patterns and hierarchy*	**Source (ANNEX 1)**
02.1	**I level (inclusive patterns:** to assess the impact of a diverse range of retrofit measures to integrate knowledge and model estimating to an appropriate level **II level (detailed patterns):** to reduce energy consumption through the reduction of energy demand; to analyse the relationship between expectations of building energy performance and the financial value of real estate; to simulate scenarios developed for analysis; to assess heating patterns; to improve exergy-based multi-objective optimisation tool; to use computer aided design (CAD) software; to examine the effects of early stage design energy modelling technology on architects' design practice; to model renewable energy supply to model battery storage; to investigate on spectrum of analysis parameters; to define high standards of energy efficiency; to improve 'systems based' approach	Parkinson et al., 2014; Calderón et al., 2015; Pye et al., 2015; Kane et al., 2015; Shatat et al., 2015; Makantasi et al., 2016; García Kerdan et al., 2016; Xie et al., 2017; Oliveira et al., 2017; Jones et al., 2017
02.2	**I level (inclusive patterns:** to investigate on the relationship between buildings and people through a process of 'interactive adaptation' to assess the interactive adaptivity and co-evolution of the physical with the social factors **II level (detailed patterns):** to improve a persona-driven study; to involve a occupants' needs; to analyse a post-occupancy evaluation; to analyse the implications for technical and behavioural research in the built environment; to improve agend-based model; to analyse actions of individual homeowners in a long-term domestic stock model; to improve comfort and living standards, reducing waste and saving on energy costs; to integrate householder attitudes and behaviours and household occupancy patterns; to assess internal heat gains; to	Haines and Mitchell, 2014; Chiu et al., 2014; Lee et al., 2014; Fawcett et al., 2014; Long et al., 2015; Marshall et al., 2015; Marshall et al., 2016; Parker et al., 2017; Santangelo and Tondelli, 2017; Lowe et al., 2017

	estimate occupancy schedules; to elaborate dynamic simulation models; to avoid reductionist approach; to assess building performance	
02.3	**I level (inclusive patterns:** to integrate life cycle energy and environmental performance to compare embodied versus operational environmental indicators **II level (detailed patterns):** to take into account the risk of projected post-2050s overheating in existing buildings	Hammond et al., 2103; Gupta et al., 2015; Azzouz et al., 2017
Cod	**3-DECISION-MAKING PROCESS:**	
	Patterns and hierarchy*	**Source (ANNEX 1)**
03.1	**I level (inclusive patterns:** to analyses multi benefit of retrofit measures to take into account uncertainties associated with the prediction **II level (detailed patterns):** to analyse financial risk; to avoid overestimation of the energy savings; to improve long-term monitoring; to individuate Building stakeholders; to analyse the role of private retrofit industry; to improve Energy Efficiency Retrofitting Services sector and define its requirement; to define the risk allocation between client and contractor in Energy Retrofit actions; to analyse the self-sufficient retrofit measures outside of a policy incentive; to compare operational performance and environmental merit of the options	Booth and Choudhary, 2013; Jones et al., 2013; Ibn-Mohammed et al., 2014; Gooding et al., 2016; Fennell et al., 2016; Gooding and Gul, 2017; Kerr et al., 2017
03.2	**I level (inclusive patterns:** to define the local green building features to follow a multi-stage development process **II level (detailed patterns):** N.D.	Gibbs et al., 2015; Busch et al., 2017
03.3	**I level (inclusive patterns:** to pursue social justice reducing fuel poverty to promote innovative financing mechanism **II level (detailed patterns):** to enhance investment impacts; to recover and reinvest some of the savings generated by early investments; to pursue government targets; to consider implications between special categories (e.g. disable people, low-income families) and energy measures; to re-configure the power sector though business model and technical innovation (e.g. distric heating)	Webb, 2015; Gouldson et al., 2015; Hamilton et al., 2016; Gillard et al., 2017; Wegner et al., 2017
Cod	**4-INNOVATIVE TECHNCIAL SOLUTIONS:**	
	Patterns and hierarchy*	**Source (ANNEX 1)**
04.1	**I level (inclusive patterns)** to assess the environmental impacts that occur from extraction, processing and manufacture of insulation to quantify and compare the environmental impact of insulation materials **II level (detailed patterns):** to disseminate the application of superinsulation materials; to provide superior thermal performance; to optimizing insulation thickness of super-insulation materials; to analyse external wall insulation; to analyse internal thermal super-insulation; to quantify thermal bridging effects	Cuce et al., 2014; Densley Tingley et al., 2015; Cuce and Cuce, 2016
04.2	**I level (inclusive patterns)** to define the building envelope features to preserve the aesthetic and structural qualities of historic buildings **II level (detailed patterns):** to investigate of the effectiveness of airtightness measures; to analysis the mechanically ventilated heat recovery system; to follow guidance relating to energy efficiency in heritage buildings	Liu, Shuli et al., 2014; Gillott et al., 2016; White et al., 2016; Ginks and Painter, 2017
04.3	**I level (inclusive patterns)** to consider the level of knowledge of local micro-enterprises to take into account stakeholders' perspective to integrate sustainable energy technologies **II level (detailed patterns):** to innovate process of construction and management; to build more adaptable buildings to consider mechanisms and management energy retrofit schemes to support private industry; to consider influence of advisers and installers in householders’ decisions to adopt low carbon technologies	Day et al.,2013; Pinder et al., 2013; Owen et al., 2014; Gooding and Gul, 2017

Cod	5-ENERGY AND ENVIRONMENTAL AWARENESS:	
	Patterns and hierarchy*	**Source (ANNEX 1)**
05.1	**I level (inclusive patterns)** to pursue a more socially transformative pathways to sustainability to improve community organisations **II level (detailed patterns):** to consider tenants' lifestyle; to investigate on local authority energy plans and exploring governance process; to improve direct control of the occupants about renewable energy system	Scott et al., 2014; Elsharkawy and Rutherford, 2105; Reeves, 2016; Webb et al., 2016; Smith et al., 2016; Hodson et al., 2106
05.2	**I level (inclusive patterns)** to analyse different technologies that have been adopted and their perceived effectiveness. **II level (detailed patterns):** to discuss the adoption of new technologies with local community to integrate marketing and outreach strategies about energy retrofit measure	Swan et al., 2013; Milner et al., 2015; Gillich et al., 2017
05.3	**I level (inclusive patterns)** to improve participatory process to organise workshops, integrating practitioner and academic perspectives **II level (detailed patterns):** N.D.	Martin et al., 2014

*Methodological note: the patterns were hierarchized in two levels. The most general and inclusive concepts were positioned at the first level, the more specific and exclusive concepts arranged hierarchically below. The integration process involved only the first level, while the second level will be articulated and integrated in the final structure of the TERCF.