DELIVERABLE 1.2

C-mapER

MARIE SKŁODOWSKA-CURIE ACTIONS

CmapER project

Case studies report and list of concepts

DELIVERABLE 1.2

MARZO 2018

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Sibilla M, Kurl E, (2018), Energy retrofit: case study report and list of concepts, H2020 MCSA IF 2016, Technical Report, Deliverable 1.2

Available online: www.energyretrofitlearningplatform.org

H2020 MSCA IF2016
c-mapER Grant Agreement 751376

CASE STUDIES REPORT AND LIST OF CONCEPTS

1 Introduction

This report fulfils the requirements of Deliverable 1.2 (D 1.2). It follows Deliverable 1.1. (D.1.1.), which previously reported on the state-of –the-art on the transdisciplinary approach to Energy Retrofit, using a literature review of 136 peer-reviewed journal papers was adopted as data source[1]. A Conceptual Framework, which comprises of five categories and 15 lines of research, was elaborated. In addition, a short-list of three concepts were linked with each line of research. Figure 1 shows the current configuration of the Transdisciplinary Energy Retrofit Conceptual Framework (TERCF).

The aim of this report is to identify key concepts that influence Energy Retrofit projects by using 10 case studies. The relationships between Energy Retrofit and urban transformation processes will also be explored.

2 Method

Our methodological approach combines qualitative analysis of the case studies with cognitive mapping technique. Case study analysis is a fundamental part of the CmapER project. Indeed, this analysis is a key instrument designed to capture information from urban contexts.

This section illustrates the method that was used for selecting them and comparing the information gathered.

Therefore, the approach adopted seeks to identify a full range of values characterizing the ER concept in the context of urban transformation processes. Specifically, in this work-package (WP1), these values are expressed in the form of *List of Concepts*, which was elaborated following the cognitive mapping technique (Novak and Cañas, 2004). Subsequently[2] (WP2) the relationships among concepts will be defined and transferred into the CmapER platform. This work-package was completed by following these steps:

1. **Selecting case studies**. Five criteria were established for the selection of the case studies: i) environmental context; ii) urban morphological condition; iii) actual building use; iv) type of construction; iv) level of protection/ legislative framework. Therefore, each case study is representative of a specific combination of the above-mentioned criteria. More details on the selection criteria are provided in the next section.
2. **Identifying main topics.** A textual report was used to present each case study[3]. Specifically, for each case study one and only one relevant topic was identified. In terms of cognitive mapping technique, this means to define a *Focus Question* and to propose a *main concept* as a starting point for the analysis. Many aspects of the Energy Retrofit cases were thus identified.
3. **Coding list of concepts**. After identifying main topics, the cognitive mapping technique was applied to the textual report. As a result, a *List of concepts* for each case study was elaborated.

[1]See:Sibilla M, Kurul E, (2017), Trans-disciplinary approach in energy retrofit: state of the art, H2020 MCSA IF 2016, Technical Report, Deliverable 1.1 Available online: www.energyretrofitlearningplatform.org.

[2]Case studies mapswill be elaborated with the final step of WP1 as milestones..

[3] See Annex A

These lists became the bases to build a multitude of relationships between the Energy Retrofit case study and the urban context examined[4].

4. **Comparison and hierarchical organisation of the concepts.** The concepts listed were compared, synthesised and re-organised in order to structure the information, and then, transfer them into the TERCF. Similar, repeated or synonymous concepts, were excluded from the combined list. In addition, the most general and inclusive concepts were positioned at the top of a concept map with the more specific and exclusive concepts arranged hierarchically below. As a result, a preliminary hierarchical structure was defined. Thus, a *Unique List of concepts* was developed[5].
5. **Linking with the conceptual framework.** Finally, the concepts were allocated to the appropriate categories and sub-categories of the conceptual framework developed in D1.1[6] in order to reinforce the contents of the TERCF. This is a preliminary allocation, which will be finalised at the end of WP1.

[4] If $X=ER_{concepts}$ and $Xn=ER_{main\text{-}concepts}$ and Y_n=Urban context. In this phase, the relationships between X_n/Y_n are identified.

[5] In this phase, the relationships between $Xn/\sum_{Y=1}^{n} Y$ emerge.

[6] The procedure, to distribute the concepts among the categories, was described in WP1.1 report.

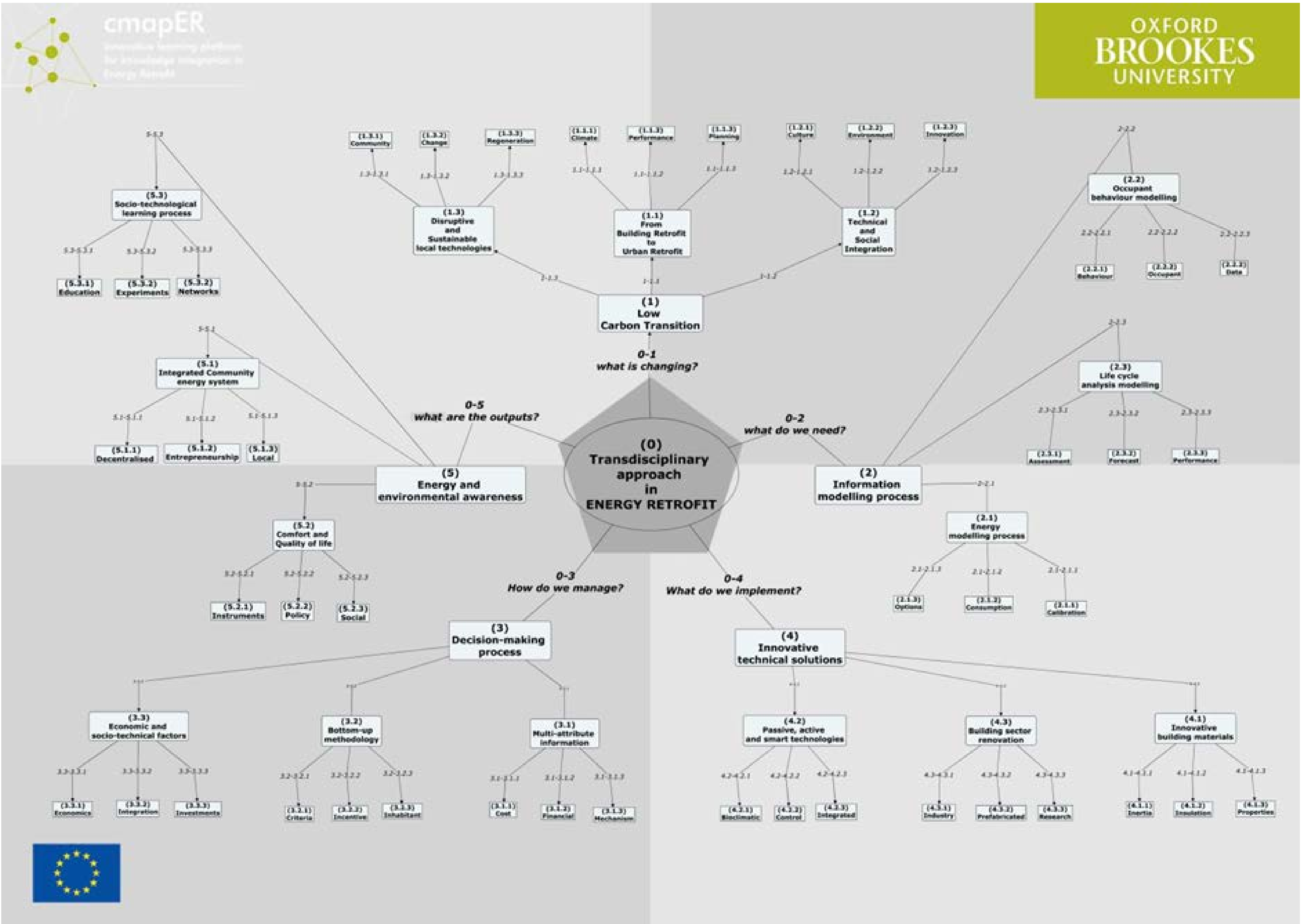

Figure 1. Current configuration of the Transdisciplinary Energy Retrofit Conceptual Framework.

2.1 Case Selection

Case Selection is the primordial task of the case study researcher in which the problem of representativeness cannot be ignored. Seawrigh and Gerring (2008) have pointed out that scholars continue to lean primarily on pragmatic considerations about *Case Selection* such as time, money, expertise, and access. They state these are perfectly legitimate factors in case selection, but they do not provide a methodological justification. Consequently, in agreement with Seawrigh and Gerring (2008), the essential issue about *Case Selection* is that researchers understand how the properties of the selected cases compare with the rest of the population (Seawrigh and Gerring, 2008).

To date various methods have been developed and introduced to select case studies. Specifically, this work adopts the *diverse case method* (Seawright and Gerring, 2008)[7]. This method facilitates the achievement of maximum variance (i.e. maximum variance on ER concepts) along relevant dimensions (i.e. dimensions of urban transformations).

Seawright and Gerring explain how *diverse case method* works: [“*It requires the selection of a set of cases, at minimum, two, which are intended to represent the full range of values characterizing X, Y, or some particular X/Y relationship. The investigation is understood to be exploratory (hypothesis seeking) when the researcher focuses on X or Y and confirmatory (hypothesis testing) when he or she focuses on a particular X/Y relationship*] (Seawright and Gerring, 2008:300).

The criteria for case study selection were established such that relevant information could be gathered to identify the key concepts, which could then be used to further elaborate the TERCF. The choice of the criteria is justified using relevant literature which highlights the importance of adopting a transdisciplinary approach to environmental design in achieving higher echelons of urban sustainability.

The first criterion (*Environmental context*) seeks to reflect the range of “environmental conditions” around Europe. Specifically, this criterion involves several relevant factors (e.g. temperature, humidity, solar and wind exposure). Indeed, the environmental contexts and buildings’ energy efficiency are interlinked issues in terms of climate adaptation strategies (Fitch, 1980; Biesbroek *et al.*, 2010). Moreover, energy efficiency of the cities is related to the urban forms (Knowles, 1974; Steemers, 2003). Consequently, the climate factors should first be considered in designing technological solutions (Olgay, 1969; Sadineni, Madala and Boehm, 2011).

The second criterion (*Urban morphological condition*) points out how cities are different in terms of their urban structure. For example, Hang, Sandberg and Li, (2009) have investigated the effect of urban morphology on wind conditions.(Wong *et al.*, 2011) have evaluated the surrounding urban morphology on building energy consumption.(Sarralde *et al.*, 2015) have analysed the solar energy and urban morphology interaction in order to assess the scenarios for increasing the renewable energy potential of neighbourhoods. It is thus clear that the urban morphological features modify the general

[7] Seawrighand Gerring present other case selection techniques as *Typical Case method* and *Extreme Case method.* The former “[…] *focuses on a case that exemplifies a stable, cross-case relationship. By construction, the typical case may also be considered a representative case, according to the terms of whatever cross-case model is employed.”* (Seawright and Gerring, 2008:299). The last “[…] *selects a case because of its extreme value on the independent (X) or dependent (Y) variable of interest. An extreme value is understood here as an observation that lies far away from the mean of a given distribution; that is to say, it is unusual”*. (Seawright and Gerring, 2008:301).

environmental conditions. Consequently, the detailed understanding of the environmental conditions in which buildings operate is a second fundamental step that characterizes the environmental design approach.

The third criterion (actual use) refers to the cost of reusing a building, both in terms of financial investment and its potential to accommodate new uses.(Shipley, Utz and Parsons, 2006) have examined the business of heritage development, which consists of building renovation or adaptive reuse, in order to determine the success factors. They state that some reuse projects are more costly than new building, but not all, and the return on investment for heritage development is almost always higher. Similarly, (Langston *et al.*, 2008) investigated the issue of building reuse in terms of investment by the construction sector. Instead, (Martín, Mazarrón and Cañas, 2010) have analysed the environmental advantages of reusing abandoned rural buildings and the compatibility of old building structures with the contemporary human need. Thus, the ER requires an accurate analysis in terms of use and reuse of buildings. Their environmental, social and economic sustainability also characterize the environmental design approach.

The fourth criterion (type of construction) concerns the energy performance of the building fabric. It is also related to the age of the building and to the traditional or innovative construction technologies. On the one hand, this criterion underlines the relationships between the quality of the construction and the energy performance. For example,(Cabeza *et al.*, 2011) have evaluated the thermal behaviour of the alveolar brick construction system, compared with a traditional Mediterranean brick system with insulation.(Cerón, Neila and Khayet, 2011) have tested the use of phase change materials (PCM) and their possible architectural integration in the search for optimizing energy efficiency in construction. On the other hand, more recent approaches to Life Cycle Analysis have expanded the factors under investigation.(Cellura *et al.*, 2014) have explored the ecological impact of the building materials introducing the life-cycle perspective by the concept of energy balance, which includes the embodied energy of a building and its components. Hence, the strengths and weaknesses of different construction technologies from an energy and environmental perspective, is another characteristic of the environmental design approach.

The last criterion takes into account the level of protection/ legislative framework. It considers the range of the level of protection (i.e. from without restriction to listed buildings). As well known, e European Union has enacted several directives dealing, directly and indirectly, with energy efficiency in buildings in order to reduce energy use. However, individual countries can adopt their own rules to include or exclude buildings from respecting the energy efficiency requirements for existing buildings. Consequently, so far, no general rules, codes or standards are available for energy retrofit of historical and architecturally valuable buildings (Mazzarella, 2015). (Martínez-Molina *et al.*, 2016) presented an extensive overview of the literature surrounding this topic, summarizing the different methods and techniques that have been used around the world to achieve higher energy performance through refurbishment. They have demonstrated the feasibility of maintaining heritage values of historic buildings while achieving significant improvements in their energy efficiency and thermal comfort. (Fabbri, Zuppiroli and Ambrogio, 2012) have investigated an evaluation and measurement tool for town energy consumption, which is related to the age and the characteristics of existing buildings. They have underlined how this problem concerns both urban planning and architectural heritage disciplines. Therefore, the environmental design emerges as a relevant approach, particularly for the old cities of Europe, to understanding how the strategies for Energy Retrofit can be diversified in relation to the historic and social stratifications at different locations.

3 Results

This section presents the main results**.**

3.1 Selected case studies.

Table 1 shows the 10 case studies selected.

code	Context	Use	Date	Construction Technology	Level of protection
01	AUSTRIA	MIX	1940-1950	Masonry	no
02	BELGIUM	SOCIAL HOUSING	1957	Reinforced concrete	no
03	FRANCE	FORMER INDUSTRIAL SITE- COMMERCIAL BUILDING	1800	Steel and Wood	no
04	GERMANY	SCHOOL	1966	Exposed concrete	no
05	ITALY	FORMER INDUSTRIAL SITE- LYBRARY	1971	Prefabricated concrete	no
06	MALTA	OFFICE	1800	Masonry	Listed Building
07	NORWAY	SCHOOL	1914	Cavity brick walls (without insulation)	Listed Building
08	SPAIN	SOCIAL HOUSING	1967	Reinforced concrete	no
09	SWEDEN	SOCIAL HOUSING	1970	Reinforced concrete	no
10	UK	FAMILY HOUSE	1890	Solid Brick wall	Listed Building

Table 1. List of the 10 case studies

3.2 Identifying main topics.

Table 2 shows the contribution of each case study in terms of *Focus Ques*tions and *Main Concepts*. Findings may be considered representative of relevant issues concerning ER in the urban context, although they are not exhaustive.

cod	Context	Focus Question	Main Concept
01	AUSTRIA	What strategies to innovate energy infrastructure and buildings?	Micro-net
02	BELGIUM	How to increase the social impact of ER actions?	Active participation
03	FRANCE	How to enhance the relation between architecture and citizens?	Functional programme
04	GERMANY	How to manage energy consumption?	Energy Consumptions
05	ITALY	How to integrate bioclimatic strategies?	Modest transformation
06	MALTA	How to increase the efficiency and ecology of building plant systems?	Cooling system
07	NORWAY	How to improve the performance of the building envelope?	Building envelope
08	SPAIN	What strategies to reduce energy poverty?	Profiles of Energy poverty
09	SWEDEN	How to deal with the level of uncertainties?	User-oriented approaches
10	UK	What strategies to reduce carbon emissions?	Legislation to reduce carbon emission

Table 2. Definition of the Focus Question and individuation of the main concept for each case study

3.2 Coding list of concepts.

The results obtained from the preliminary analysis of each case study can be compared in table 3. Interestingly, only about 12% of repetitions were observed. Thus, the result indicates that each case study provided a specific relationship between ER and Urban context.

Context	List of concepts	N. concepts
AUSTRIA	Urban quality, District heating Integrate renewable energy in existing, Supply system, Renewable energy, Heat pump, Solar collector Micro-net, Planning directives Detailed simulation, Decision-making-process, Social aspects of retrofit, Reduce heat demand, Building physics, Vacuum-panels, Air ventilation system, Minimize overheating, Optimized active cooling system, Information point; Tenants behaviour	20
BELGIUM	Residential character; Artistic expression; Balanced choice of materials; Environmental performance; Aesthetics; Improve the comfort of the inhabitants; Limate the energy costs of the tenants ; Passive design; Reduce the environmental footprint; Thermal bridges; Breaks the monotony of the facades; Artistic intervention ; Materials are chosen without organic volatile compounds (vocs); Thermal insulation; Ventilation; Habitability	16
FRANCE	Ecological aspect; Relation between architecture and citizens; Improve the quality of life; Promote the awareness; Functional programme; Need and requirements of the local population; Recyclable material; Diversified functional mix; Production from renewable sources; Recovery of heat; Geothermal energy; High thermal-acoustic properties; Rockwool; Thermal inertia ; Ensure summer thermal comfort; Highly populated building; Prefabrication as Innovative technology; PV panels	17
GERMANY	Energy consumption; Heat consumption ; Indoor environmental quality; Pvc-framed double glazed windows; Windows of single glazing; U-values ; Building envelope; Ventilation systems ; Mechanical ventilation; Cogeneration plant (CHP) ; Heat demand; PV Modules orientated ; Cross air flow Decentralized ventilation units ; Heat recovery; Reflection factors ; Monitoring; Indoor air quality ; Monitoring technology; Communication technology	18
ITALY	Development and progress of this city; Economic dynamics; Political vision; City's cultural life; Modest transformations; Architectural expression; Light capture Natural ventilation systems ; "Sun chimneys"; Low-emissivity glass; Natural lighting; Natural difference pressure; Air extraction; Administrative needs	14
MALTA	Night time convective ventilation (passive night cooling); Passive downdraught evaporative cooling system (PDEC). Direct cooling; Indirect cooling; Cooling system; Thermal comfort; Well-being;Save on the use of artificially generated energy; Control the relative humidity in the air; Thermal performance; Adaptability Protected building; Building Management System (BMS); Bioclimatic strategies; Passive systems; Active systems	16
NORWAY	Building envelope; Space heating system; Ventilation system; Sanitary hot water system; Electric lighting system Renewable energy system; Management system; Passive solar gains; Avoid glare; Overheating; Geothermal energy source; Avoid moisture; External insulation; Buildings' aesthetics; Long life expectation ; Affordable operational and maintenance costs; Building energy management system (BEMS); Space heating control; Ventilation control; Lighting control; Monitor the energy consumption	21
SPAIN	Job creation; Retrieve industrial and professional activity ; Construction sector; Profile of energy poverty; Energy bills; Health risk conditions; Geographic concentration of obsolete buildings ; Vulnerability; Risk of exclusion; Neighbourhood; Financial mechanisms; Economically feasible projects; Payback in reasonable timing; Energy services companies; Representative groups; Low-income families; Influence of compactness; Economic aspects; Social aspects; Real estate market	19
SWEDEN	Living standards; Active participation Preheating domestic hot water ; Fresh air preheated; Greenhouses; Prevailing winds; Communal greenhouses; Heat recovery; Thermal conduction; Extra layer of thermal insulation and a cavity; Low-emission panes; Occupancy sensors; Metering systems ; User-oriented approaches; Climate-oriented design approaches; Uncertainties; Building's lifetime ; Household appliances; Occupant behaviour; Maintenance support; Climatic conditions	21
UK	Legislation To Reduce Carbon Emissions; Insulation; insulation; Wood Fibre Insulation; Rotex Combined Gas-Solar Unit; Solar Thermal Panels; Mechanical Ventilation; Triple Glazed Windows; Air Permeability; Systems Can Operate In Conflict; Consumption; Differences Between Forecast Consumption And Actual Use; Errors on The Initial Forecast Model; Differences In Expected Occupant Use; Energy And Actual Use; Monitoring Methodology; Fabric Performing; Low Carbon Systems Performing; Use Of The Building By Occupants; Predict Performance; Energy Systems use On A Month To Month Basis	21
	Total concepts	183

Table 2. List of concept collected

3.3. Comparison and hierarchical organisation of the concepts

In Figure 2 the *UniqueList of concepts is shown.*

3.4 Linking with the conceptual framework (TERCF).

The preliminary distribution of concepts within the TERCF is based on a qualitative connection between the *Main Concepts* (D.1.2) and the prior concepts listed into the TERCF (D.1.1). They are not static connections. Specific linking phases will be developed in the next phase of the research. In Table 3 *Main concepts* and their preliminary distribution within the TERCF is shown. Specifically, in order to justify the qualitative connections proposed some comments from the researcher are provided.

Main Concept	TERCF Concept	Category and Line of Research	Researcher's comments
Micro-net	Decentralised	Energy and environmental awareness: Integrate Community Energy System	Micro-net is a form of decentralised energy system.
Active participation	Community	Low Carbon Transition: Disruptive and Sustainable local technologies	Active participation involves local communities
Functional programme	Instruments	Energy and environmental awareness: Comfort and Quality of life	Functional programme is an instruments to improve the quality of life
Energy Consumptions	Forecast	Information modelling process: Life cycle analysis modelling	Energy Consumption analysis is often associated to its forecast
Modest transformation	Innovation	Low Carbon Transition: Technical and Social Integration	Modest transformation is a form of innovation, which seeks to point out the main factors that generate high level of energy consumption within a specific context.
Cooling system	Integrated	Innovative Technical Solution: Passive, active and smart technologies	Cooling systems require integration strategies, enhancing passive and active strategies
Building envelope	Property	Innovative Technical Solution: Innovative building material	Building envelope performance is related to the property of the envelope components
Profiles of Energy poverty	Integration	Decision making process: Economic and socio-technical factors	Profiles of Energy poverty require integration between economic and socio-technical factors
User-oriented approaches	Behaviour	Information modelling process: Occupant behaviour modelling	User-oriented approaches is focused on users' behaviour
Legislation to reduce carbon emission	Criteria	Decision making process: Bottom-up methodology	Legislation to reduce carbon emission requires identifying the criteria on which the energy transition has to be developed.

Table 3. Main concepts and their preliminary distribution within the TERCF.

4 Conclusion and perspective

The present study was designed to augment the TERCF by including the concepts that emerged from the case study analysis. The main goal of this phase of the study was to determine *Focus Questions* and the *Main Concepts*, which were useful for representing relevant issues concerning Energy Retrofit in the urban context. Therefore, this research extends our knowledge of transdisciplinary approach in Energy Retrofit. Nevertheless, the most important limitation lies in the fact that the results of this phase did not show the linking phrases among concepts. Consequently, further experimental investigations are needed to establish these linking phrases. In the next phase of the research, the case studies will be translated into cognitive maps. Subsequently, each relationship proposed in the TERCF will be defined in order to develop a learning platform for knowledge integration in Energy Retrofit.

0	Micro-net
1	Communication technology
1.1.	Metering systems
1.1.1.	Systems Can Operate In Conflict
1.1.2.	Household appliances
1.1.3.	Maintenance support
1.1.4.	Space heating control
1.1.4.1.	Overheating
1.1.4.1.1	Ventilation control
1.1.4.1.2.	Lighting control
2	Supply systems
2.1	Space heating system
2.1.1.	Cogeneration plant (CHP)
2.1.2.	Heat pump
2.1.3.	Recovery of heat
3	Active systems
3.1.	Production from renewable sources
3.1.1.	Renewable energy system
3.1.1.1.	Integrate renewable energy in existing
3.1.1.1.1.	PV Modules orientated
3.1.1.1.2.	Solar collector
3.1.1.1.2.1.	Sanitary hot water system
3.1.1.1.2.1.1.	Preheating domestic hot water
3.1.1.2.	Geothermal energy

0	Active participation
1	Development and progress of city
1.1.	Planning directives
1.1.1.	Neighbourhood
1.1.1.1.	Decision-making- process
1.1.1.1.1	Relation between architecture and citizens
1.1.1.1.1.1	Information point
1.1.2.	Administrative needs
2	City's cultural life
2.1.	Aesthetics
2.1.1.	Buildings' aesthetics
2.1.1.1.	Architectural expression
2.1.1.1.1.	Breaks the monotony of the facades
2.1.2.	Artistic expression
2.1.2.1.	Artistic intervention

0	Functional programme
1	Climate-oriented design approaches
1.1.	Climatic conditions
1.1.1.	Adaptability
1.1.1.1.	Habitability
1.1.1.1.1.	Diversified functional mix
1.1.1.1.1.1	Environmental performance
2	Geographic concentration of obsolete buildings
2.1.	Protected building
2.2.	Building's lifetime
2.2.1.	Long life expectation

0	Energy Consumptions
1	Indoor environmental quality
1.1.	Ensure summer thermal comfort
2	Building energy management system (BEMS)
2.1	Detailed simulation
2.1.1.	Heat consumption
2.1.1.1.	Energy Systems use On A Month To Month Basis
2.1.1.2	Reduce heat demand
2.1.1.3.	Save on the use of artificially generated energy
2.2.	Affordable operational and maintenance costs
3	Differences Between Forecast Consumption And Actual Use
3.1.	Errors on The Initial Forecast Model
3.2.	Differences In Expected Occupant Use
3.2.1.	Highly populated building

0	Cooling system
1	Optimized active cooling system
1.1.	Direct cooling
1.1.1.	Passive downdraught evaporative coo
1.2.	Indirect cooling
2	Air ventilation system
2.1.	Mechanical ventilation
2.1.1.	Decentralized ventilation units
2.1.1.1	Minimize overheating
2.1.1.1.1.	Fresh air preheated
2.1.1.1.2.	Night time convective ventilation (pas
2.1.1.1.3.	Electric lighting system
2.2.1.2.	Control the relative humidity in the ai

0	Building envelope
1	Fabric Performing
1.1.	Influence of compactness
1.2.	Thermal comfort
1.2.1.	Thermal performance
1.2.1.1.	Thermal conduction
1.2.1.1.1	U-values
1.2.1.1.1.1.	Insulation
1.2.1.1.1.1.1	Polystyrene insulation
1.2.1.1.1.1.2	Wood Fibre Insulation
1.2.1.1.1.1.3	Rockwool
1.2.1.1.1.1.4	Windows of single glazing
1.2.1.1.1.1.5	Pvc-framed double glazed windows
1.2.1.1.1.1.6	Triple Glazed Windows
1.2.1.1.1.1.7	Vacuum-panels
1.2.1.1.1.2	External insulation
1.2.1.1.1.3	Thermal bridges
1.2.1.2.	Thermal inertia
1.2.1.3.	Reflection factors
2	Prefabrication as Innovative technology
2.1.	High thermal-acoustic properties
2.1.1.	Low-emission panes
2.1.2.	Low-emissivity glass
2.2.	Avoid glare
2.3.	Avoid moisture
2.4.	Materials without organic volatile compounds (vocs)
3	Building Management System (BMS)
3.1.	Building physics

0	Profile of Energy poverty
1	Social aspects
1.1.	Residential character
1.1.1.	Communal greenhouses
2	Economic dynamics
2.1.	Economically feasible projects
2.1.1.	Financial mechanisms
2.1.1.1.	Limate the energy costs of the tenants
2.1.1.1.1	Energy bills
2.1.1.1.2	Low-income families
2.1.1.1.3	Payback in reasonable timing

0	User-oriented approaches
1	Improve the quality of life
1.1.	Need and requirements of the local population
1.1.1.	Representative groups
1.1.1.1.	Occupant behaviour
1.1.1.1.1.	Tenants behaviour
1.1.1.2	Living standards
2	Improve the comfort of the inhabitants
2.1.	Well-being
2.2.	Health risk conditions
3	Predict Performance
3.1.	Use Of The Building By Occupants
3.1.1.	Monitoring technology
3.1.1.1.	Occupancy sensors
3.1.1.2.	Monitoring Methodology
3.1.1.2.1	Monitor the energy consumption
3.1.1.2.2	Monitoring Indoor air quality

0	Modest transformation
1	Bioclimatic strategies
1.1.	Passive design
1.1.1.	Natural lighting
1.1.1.1.1	Light capture
1.1.2.	Passive systems
1.1.2.1.	Passive solar gains
1.1.2.2.	Sun chimneys
1.1.2.3.	Greenhouses
1.1.3	Ventilation
1.1.3.1	Ventilation systems
1.1.3.1.1	Natural ventilation systems
1.1.3.1.1.1	Natural difference pressure
1.1.3.1.1.1.1	Cross air flow
1.1.3.1.1.1.2	Air extraction
1.1.3.1.1.1.3	Air Permeability
2	Balanced choice of materials
2.1.	Extra layer of thermal insulation and a cavity

0	Legislation To Reduce Carbon Emissic
1	Low Carbon Systems Performing
1.1.	Economic aspects
1.2.	Vulnerability
1.3.	District heating
2	Political vision
2.1.	Reduce the environmental footprint
2.2.	Promote the awareness
2.3.	Job creation
2.3.1.	Energy services companies

Figure 2. ***Unique List of Concepts*(161 concepts) and its preliminary hierarchy structure.**

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