universität wien

MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

TOWARDS ENERGY EFFICIENT BUILDINGS. ARE WE TAMING WICKED PROBLEMS IN EXISTING BUILDING STOCK?

verfasst von / submitted by

Margarita Nutfulina

angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Master of Arts (MA)

Wien, 2017 / Vienna, 2017

Studienkennzahl lt. Studienblatt / degree programme code as it appears on the student record sheet:	A 066 664
Studienrichtung lt. Studienblatt / degree programme as it appears on the student record sheet:	Masterstudium DDP Urban Studies
Betreut von / Supervisor:	Manuel Valenzuela

Deutsche Version

Erklärung

Hiermit versichere ich,

- dass die ich die vorliegende Masterarbeit selbstständig verfasst, andere als die angegebenen Quellen und Hilfsmittel nicht benutzt und mich auch sonst keiner unerlaubter Hilfe bedient habe,
- dass ich dieses Masterarbeitsthema bisher weder im In- noch im Ausland in irgendeiner Form als Prüfungsarbeit vorgelegt habe
- und dass diese Arbeit mit der vom Begutachter beurteilten Arbeit vollständig übereinstimmt.

English Version

Statement

I hereby declare,

- that I have authored the present master thesis independently, did not use any sources other than those indicated, and did not receive any unauthorized assistance,
- that I have not previously submitted this master thesis topic in any form, in this country or any other, for academic credit,
- and that this work is identical to the one assessed by the registered supervisor.

Wien / Vienna

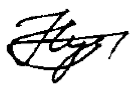
Datum / Date:

01.09.2017

Name (Nachname, Vorname) / Name (Last name, First name):

Margarita Nutfulina

Unterschrift / Signature:



CONTENT

ABSTRACT

Buildings play an important role in the global green transition, enabling countries and cities to reach their climate targets through measures of energy efficiency. However, in light of the apparent benefits of energy efficiency, evidence suggests that current energy efficiency potentials remain largely untapped, meaning that energy efficiency of the buildings has not been implemented at the rate that it should be. This has been labelled as the Paradox of Energy Efficiency; on the one hand having a clear set of goals for EEB implemented by governments and cities, and on the other hand not being able to achieve these goals despite the availability of cost-efficient solutions. The goal of the thesis is to provide clarity around this phenomenon. In order to investigate the energy efficiency gap with a focus on the building sector, the study identifies which barriers exist in the case of implementing energy efficiency of the buildings. Secondly, it analyses the nature of these barriers though Wicked, Tame and Critical problem lens and consequently suggest approaches to solve them by applying Clumsy Solution Model. The aim of this thesis is to undertake case studies of Copenhagen and Madrid and match the empirical data with theories on problems and problem solving. This study researches the impediment that authorities are potentially confronted with when implementing energy efficiency in the building sector, examines the role of actors and addresses the challenge of overcoming the barriers.

INTRODUCTION

1. INTRODUCTION

1.1 OPENING

CITIES AND CLIMATE CHANGE - THE IMPORTANCE OF BUILDING LOW-CARBON CITIES

Despite the uncertainties and complexity of the world's climate system, the evidence of global warming is becoming more and more convincing. Global temperature changes always take place, however, the pace of these changes has never been as fast as it has been during the past few decades. The evidence is found in measurements of air and ocean temperatures and from phenomena such as increases in average global sea levels, retreating glaciers, and changes in many physical and biological systems (IPCC, 2007). Global warming is being explained as a product of human activity, which consequently increases concentration of carbon dioxide emissions. The amount of CO2 in 1960 was 37% of nowadays figures (La Roche, 2009). Reports from the IPCC show that on going climate change will have significant impact on societies, the global economy and on the environment. Multiple bodies of scientific research find that human activity is the main driver for the recent global warming trend, which was acknowledged by the international community in December 2015, when 175 member states signed the Paris Agreement unanimously to change the course of the global climate. Carbon-based energy consumption increases the greenhouse gases emissions (IPCC, 2007), and altering this phenomenon requires a transition towards low-carbon development.

Nowadays, more than half of the world's population inhabit cities. Cities provide opportunities, benefits and economic growth but at the same time, cities are consuming 75% of the world's energy and responsible for over 70% of worldwide carbon emissions (Girardet, 2008). The UN's projection estimates that 70% of the world's population will become urbanized by 2050. Therefore, due to urbanization, cities are major actors in the transition towards a sustainable low-carbon future, which places them with the highest jurisdiction above energy operations control: energy supply and management, transportation systems, land-use zoning patterns, building codes and waste management (Wei, 2011). Researchers have also highlighted, that the 'city' is at the ideal administrative level to address climate change issues (Bai, 2007).

THE ROLE OF BUILDINGS IN CLIMATE CHANGE

The building sector plays an important role in the global climate change process. In Europe, the building sector is responsible for 40% of primary energy consumption (Figure 1) and 36% of total CO2 emissions (Haydock, 2009; Levine et al, 2012).

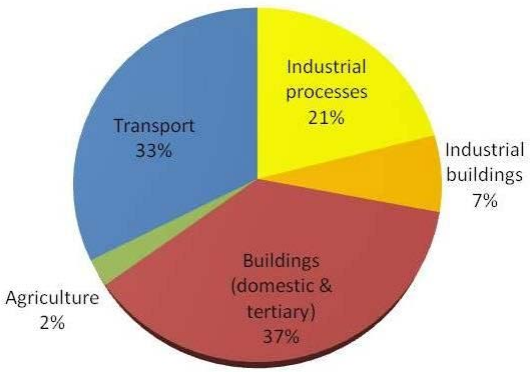


Figure 1. Share of total EU energy consumption (Directorate-General for Energy and Transport , 2010).

Decreasing energy consumption and increasing renewable energy production are the main objectives for European countries to reduce their

share of CO2 emissions, improve energy security and instability of the fossil-fuel global market (European Environment Agency, 2015). The European Union has set a long-term goal to achieve an 80% cut in domestic emissions compared 1990 by 2050. Acknowledging that a high potential of energy-saving and CO2 reduction lies in the building sector, Europe aims to meet this goal by using innovative technology in new buildings and refurbishing old buildings (European Commission, 2010).

There are different mechanisms by which buildings emit carbon compounds. Each building is responsible for CO2 emissions during its construction process, maintaining/operating the building itself, use of water, waste production and indirectly responsible for carbon dioxide emissions due to transport services (La Roche, 2009). Therefore, to reduce humans' contribution to global warming, CO2 emissions from buildings must be minimized by making them as energy-efficient as possible, while conserving valuable energy sources. In Europe, most of the present buildings were constructed at the time when EE was not on the agenda, and consequently these buildings have high demands for energy in order to provide heating, cooling and electricity supply.

1.2 PROBLEM SETTING

GOALS ARE SET BUT NOT REACHED

Building low-carbon cities is a popular, yet not a brand new idea. Environmental studies have their roots from the late 19th century, while environmental planning has been accelerating since the 1960 when environment recognized as a driver for social desirable change (Bulkeley, 2005; Wei, 2011).

Although there are a variety of policy contexts and a large availability of technological know-how to reduce energy consumption in buildings, the majority of cities have not harnessed the energy efficiency potential of their building stock. Most developed countries and many developing countries have already taken steps towards reducing greenhouse gas emissions from the building sector, but these steps have had a limited impact on actual emission levels.

It is due to the so called *Energy-Efficiency Gap*, which describes the difference between actual and optimal energy use in buildings: 'Energy-efficient technologies offer considerable promise for reducing the costs and environmental damages associated with energy use, but these technologies appear not to be used by consumers and businesses to the degree that would apparently be justified, even on the basis of their own (private) financial net benefits. For some 30 years, there have been discussions and debates about this phenomenon among researchers and others in academia, government, non-profits, and private industry, typically couched in terms of potential explanations of the so-called "energy efficiency gap" or "energy paradox' (Stavins, 2016, [Web log comment]).

Many studies have been conducted in order to understand the energy gap phenomenon and why EE is so difficult to achieve (Lee & Yik, 2004; Economidou, 2011; Gillingham & Palmer, 2014; Adam & Stavins, 1994; Hirts & Brown, 1990).

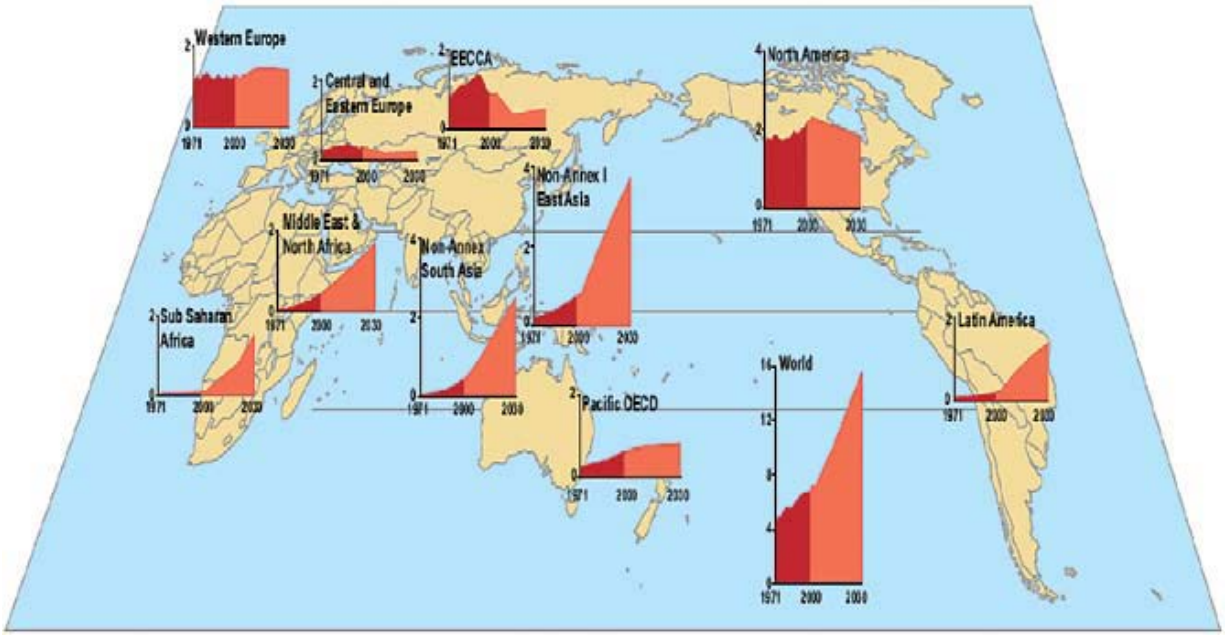


Figure 2. CO**2** emissions from buildings. Note: Dark red: historic emissions, light red: projections 2001 – 2030 (Levine et al, 2007).

One of the main arguments is that there are a number of barriers due to the complexity of stakeholders with different interests, which are involved at various stages of the building's lifecycle. Risks and uncertainties associated with the costs and the effectiveness of a given policy or action also add complexity to the process (Ayourb, Batres, & Naka, 2009). Overall, there is also still a lack of practical knowledge about how to implement EE measures (UNEP, 2009).

Scholars have discussed how the climate change phenomenon is characterized by difficulty in problem definition, complexity of related actors' networks, scepticism regarding costs and consequences of a given policy, as well as risk and uncertainties regarding the future (Bai, 2003; Delarue, Meeus & Azevedo, 2013; Biermann, 2010). These characteristics typify climate change and environmental sustainable development as a '*Wicked problem'* (Ayourb, Batres & Naka, 2009; Pollitt, 2015), and many scholars have investigate this phenomenon (Akamani, Holzmueller & Groninger ,2016; Artmann, 2014; Balint, Stewart et al., 2011; Head, 2014; Lönngren & Svanström, 2016).

RESEARCH QUESTION

1.3 RESEARCH QUESTION

Buildings play an important role in the global green transition, enabling countries and cities to reach their climate targets through measures of EE. However, in light of the apparent benefits of EE, evidence suggests that current EE potentials remain largely untapped, meaning that energy efficiency of the buildings (EEB) has not been implemented at the rate that it should be. This has been labelled as the Paradox of Energy Efficiency; on the one hand having a clear set of goals for EEB implemented by governments and cities, and on the other hand not being able to achieve these goals despite the availability of cost-efficient solutions.

Therefore, in order to investigate the energy efficiency gap with a focus on the building sector, it is necessary to determine which barriers exist in the case of implementing energy efficiency of the buildings (EEB). Secondly, it is important to understand the nature of these barriers and consequently suggest appropriate approaches to solve them. This leads to the following research question:

WHAT ARE THE MAIN BARRIERS IN IMPLEMENTING ENERGY EFFICIENCY IN THE BUILDINGS SECTOR IN EUROPE?

SUB QUESTIONS:

- WHAT ARE THE MAIN BARRIERS IN IMPLEMENTING ENERGY EFFICIENCY IN THE BUILDINGS SECTOR IN COPENHAGEN?
- WHAT ARE THE MAIN BARRIERS IN IMPLEMENTING ENERGY EFFICIENCY IN THE BUILDINGS SECTOR IN MADRID?
- TO WHAT EXTENT THE PROBLEMS IN COPENHAGEN AND MADRID CONSTITUTE THE WICKED PROBLEM ASPECT?

The aim of this thesis is to undertake case studies of Copenhagen and Madrid and match the empirical data with theories on problems and problem solving. This study researches the impediment that authorities are potentially confronted with when implementing EEB, examines the role of actors and addresses the challenge of overcoming the barriers.

THEORETICAL FOUNDATION

2. THEORETICAL FOUNDATION

2.1 GREENHOUSE GAS EMISSIONS FROM THE BUILDINGS

Buildings are responsible for CO2 emissions during the manufacturing of building materials, construction process, maintaining/operating the building itself, use of water, waste production and indirectly responsible for carbon dioxide emissions due to transport services. A significant share of greenhouse gas emissions comes from the construction of buildings. Manufacturing materials, especially insulation materials, refrigeration and cooling systems, transportation of materials and construction process contribute to emissions. Moreover, each building has a life duration and needs to be demolished afterwards (La Roche, 2009).

Evidence suggests that the largest share of energy is applied during the building exploitation process due to the demand of maintaining the building's operating systems such as heating, ventilation, air conditioning and lighting, and as a result over 80% of total emissions take place during this phase (Haydock, 2009). Greenhouse gas emissions from building operations primarily arise due to their consumption of fossil fuel based energy, both through the direct use of fossil fuels (natural gas) and through the use of electricity, which has been generated from fossil fuels (La Roche, 2009).

However, energy consumption during the operational phase of a building depends on different interrelated factors such as geography, climate type, weather conditions, location, function of a building and the behaviour of its users (Haydock, 2009). For instance, a competent spatial urban planning plays important role in achieving low-carbon targets. The placement of buildings in densely populated urban areas and near public transportation lines also reduces the emissions of carbon dioxide from transportation (La Roche, 2009).

The level of greenhouse gas emissions from buildings is closely correlated with the level of demand, supply and source of energy (Haydock, 2009).

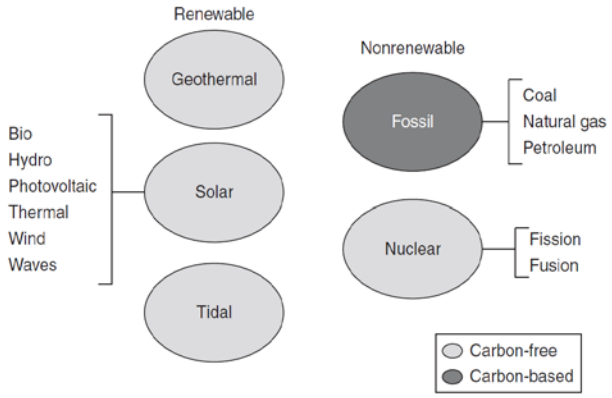


Figure 3. Primary sources of energy: renewable and non-renewable (Incropera, 2015).

Primary energy sources are highlighted in the figure above (Figure 3). Non-renewable sources of energy consist of fossil and nuclear fuels, which are stored within the Earth.

Although fossil fuels have sustained economic growth since the eighteenth century, continued extraction leads to depletion or to a point where reserves are so diminished that further extraction is impractical. Besides that, an important concern is that products of combustion include carbon dioxide, which heavily contribute to global warming. In contrast, nuclear fuels are carbon-free. Nuclear energy can be released by means of a fission or fusion reaction. However, the process of power production is high-priced in terms of costs and engineering provision. Renewable forms of energy are carbon-free and for all practical purposes can never be depleted. Solar energy is the most sufficient source of renewable energy. Due to the process of photosynthesis, solar energy becomes a chemical energy in the form of biomass and biofuel. Solar radiation is responsible for temperature variations on land and sea and consequently sustain the Earth's hydrologic cycle and atmospheric winds, which can be tapped as sources of hydro, wind, and wave energy (Incropera, 2015).

2.2 EMISSION REDUCTION MECHANISMS

Scholars suggest differentiating the potential mechanisms to reduce energy use in the building sector and decrease CO2 emissions, between policies, technology and consumers behaviour (Haydock, 2009; Levine et al, 2012).

TECHNOLOGY TOOLS

There are a large number of technologies available on the market with a potential to improve EEB. Efficient design starts from an efficient building envelope, including north orientation, roof design, natural lighting and ventilation, suitable insulation in walls; as well as integrated site and landscape design. Popular technology options for heating and cooling in buildings with long-term potential for reducing emissions are technologies for space and water heating, dehumidification, heat pumps for heating and cooling, thermal storage, through photovoltaic, passive and active solar techniques. However to achieve the highest potential, buildings require a holistic approach to maximize savings and minimize costs, which involves and activates systems rather than technologies. Besides current technology and appliances there is a constant demand for research and development (R&D) in the field (Levine et al, 2012).

POLICY TOOLS

Frameworks, clear vision and targets for EE need to be established at the highest governmental level and accompanied by allocating finance and resources for implementation of sectoral policies and addressing market imperfections simultaneously (Thomas, 2015). For decision-makers at the sector-specific level to control and regulate energy consumption and CO2 emissions, they have to manage appropriate data and information about their building sector, tools to analyse the data, and therefore the ability to coordinate and facilitate policies aiming to reduce emissions from the buildings (Thomas, 2015; UNEP, 2009). The diversity and fragmentation of the building type within the region is considered as an important issue.

There are well-known policy instruments such as regulations, incentives and financing, which together create a comprehensive policy package targeting EEB. The baseline to regulate energy efficiency is the availability of the energy use and efficiency data, which could be

measured by energy performance indicators. Therefore, energy performance requirements are an essential tool of a GHG mitigation strategy for Buildings (UNEP, 2009). According to UNEP, most of developed countries have established energy performance requirements on the national level by setting building codes, energy efficiency standards, labels, commissioning of buildings regarding the operations of building's systems, self-regulation and fine-tuning by occupants of energy consumption (UNEP, 2009). However, the appropriate integration of policies with each other is important: if policy instruments interact and reinforce each other, it will transform the markets and drive EE in a long run (Thomas, 2015).

At the European level, energy consumption is targeted by the EU Action Plan for Energy Efficiency and the Energy Performance of Buildings Directive (EPBD). EPBD is designed to meet Kyoto Protocol and it is main policy driver related to the energy use in buildings. (Haydock, 2009). Implemented in 2002, the Directive has been recast in 2010 with more ambitious targets. The Directive is set to force member states to implement the general framework for a methodology of calculation of the integrated energy performance of buildings, the application of minimum requirements on the energy performance of new buildings and existing buildings that are subject to major renovation (Dijk, Wouters, & Hogeling, 2008). Furthermore, the Directive makes certificates for the energy performance of buildings mandatory and requires regular inspections of boilers and air-conditioning systems.

BEHAVIOUR

The performance of the city and the buildings particularly depends on its users. The relevant literature suggests ways to influence the behavioural change in order to reach EE (European Environment Agency, 2013; Gillingham & Palmer, 2009; Owens & Driffill, 2008; UNEP, 2009).

There are many different factors that influence consumer behaviour and everyday life attitudes: age, social background, beliefs system, economic situation, level of education, technology using skills. EEA report provides simplified table that shows main factors and actors behind influencing consumer's behaviour.

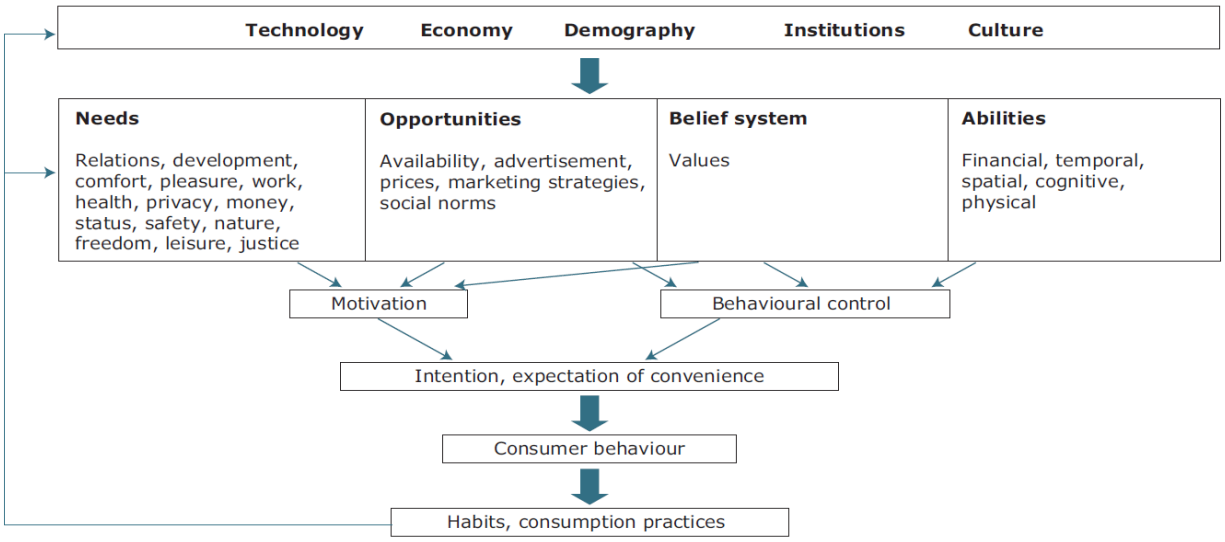


Figure 4. Main factors influencing consumer behaviour and emergence of consumption practices (Adapted by EEA from the NOA model described in Darton 'Methods and Models', 2010).

The European Environment Agency (EEA) argues that there is a tendency to consider those factors and relationships between them as a fixed fact while in reality there is a fluctuation and consequently a constant change in consumer's preferences and practices. Therefore, the study suggests shifting the focus from individual behaviour per se to consumption practices of the society (European Environment Agency, 2013).

The different initiatives and practices can be categorized as tambourines, carrots and sticks according of the type of influence on consumers. Azeved considers tambourines as 'soft' policy mechanisms that oriented to raise awareness of the issues among stakeholders on expectations from them and ways to achieve it (Azeved, Delarue & Meeus, 2013). In the case of consumer behaviour towards the energy efficiency of building stock, tambourines can be communication and engagement campaigns, educational programs, promotions, trainings, goal-setting, feedback, etc. By carrots, the scholar implies policy mechanisms that encourage users to act by providing support and awards, while sticks are aimed to punish low performance by sanctioning it (Azeved, Delarue & Meeus, 2013). Considering a EEB, there are a variety of practices with financial and regulatory nature that can be viewed as carrots (to influence people by intervening their finance through subsidies, taxes, bonuses, rewards) and sticks (penalties, rules, specific exemptions, building certifications and labelling, etc.).

Additionally, energy infrastructure adds the specificity of behaviour related to the energy consumption. The growing body of literature evaluates and measures user experiences with different types of energy-efficient buildings and equipment (Hauge, Thomsen & Berker, 2011; Masoso & Grobler, 2010). The result identifies a mismatch between predicted and real performance of users.

2.3 POTENTIAL BARRIERS INTO ENERGY EFFICIENCY IN THE BUILDING SECTOR

As discussed above, cities have not mobilized toward low-carbon development, although the necessity is clear. Most countries have taken actions and introduced policies to reduce greenhouse gas emissions from buildings. However, those policies have not resulted in an actual significant reduction in emissions (UNEP, 2009). The relevant literature suggests that recently obstacles in EEB became more evident with growing complexity of government and decision making arrangements and regulating the environment more by free market and voluntary approaches (Middle, 2010).

EEB has many potential sources of failure due to a complex sociotechnical nature of the system where diverse actors act at the intersection of industry and market structures, institutions of governance, innovation systems, evaluation practices, supplier-user chains, designer and engineering practices, etc. The building sector has unique characteristics such as a fragmented long lifecycle of the buildings, extended supply chain, difference in the

attitude between owners and users, spatially fixed nature of products and production processes, high capital costs, etc. (OECD, 2003; Ryghaug, 2008)

2.4 PROBLEMS NATURE

In order to investigate the barriers related to EEB, the thesis includes theories on discourse, problem identification and problem solving, which will be presented in the following chapters.

The choice of theories are related to the apparent paradox of EE mentioned in the earlier chapters; on the one hand having a clear set of goals for EEB implemented by governments and cities, and on the other hand not being able to achieve these goals despite the availability of cost-efficient solutions. As also mentioned in previous chapters, however relevant EE may seem for buildings, overcoming the barriers of implementation requires a coordinated engagement of a large and diverse group of stakeholders in a complex system of rules and regulations, and therefore presents a different implementation challenge compared with for instance energy supply, where decisions are centralised in large companies or government ministries.

Furthermore, the choice of theories included on problem identification, problem solving and discourse are related to theories positioned on climate change, since the barriers and challenges related to EEB are largely understood as important elements in the aspects of climate change barriers and developments as a whole. This is evident through the use of a shared discourse between climate change and EE, for instance vocabularies on greenhouse gas emissions and energy consumption patterns, as well as inclusion of EE as a core element in environmental and climate-related discourses.

With the above in mind, the thesis commences with an introduction of *Discourse Theory* followed by theories on problem analysis concerning *Tame and Wicked problems*. This is followed by theories on problem solving concerning *Clumsy Solutions*.

2.5 UNDERSTANDING THE PROBLEMS

In order to investigate the barriers related to energy efficiency in buildings, discourse theory is used to understand and interpret the qualitative and quantitative empirical data. A key assumption underlying discourse theories builds upon the “post-linguistic turn” (Mumby, 2008: 3427), that language is a central and constructing element of human meaning and social reality formation. This means that language is not just a mirror of reality but instead that language and language use are important features in constructing reality, which in the context of the thesis is relevant in terms of understanding the reality of barriers to energy efficiency in buildings.

The understanding of language as a system that is not determined by the reality from which it refers to can be traced back to the structural linguist Ferdinand de Saussure. By distinguishing between to levels of language, langue and parole, Saussure argued that langue should be considered as the structure of language and parole should be understood as

language use in specific situations.

To relate the terms of langue and parole in discursive terms, it is possible to draw on Alvesson and Kärreman's distinction between little d discourse and big D discourse (Alvesson & Kärreman, 2000). Little d discourse refers to the talk and text in situated contexts, what can be called a micro distinction, and can thus be related to the term parole. Big D discourse refers to the culturally standardized interpretive frames of a given topic, what can be called a macro distinction, and can thus be related to the term langue.

It is in the interplay between the micro and macro that meaning is created and sustained by different stakeholders, which is described by Norman Fairclough as the interplay between actual discourses, the macro distinction, and the actual practices, the micro distinction: *We always experience the society and the various social institutions within which we operate as divided up and demarcated, structured into different spheres of action, different types of situation, each of which has its associated type of practice (Fairclough, 2001: 29).*

In the context of the thesis, little d discourse refers to the talk and text from the primary and secondary data, which describes any knowledge about specific barriers related to energy efficiency in buildings. Big D discourse refers to the overall meaning of barriers related to energy efficiency in buildings, for instance by looking at structural barriers or political barriers from a more general perspective. The interplay between little d discourse and Big D discourse will be used in the analysis to identify which barriers exist and to contemplate over why they exist, or put differently, to classify the actual practices surrounding the barriers to energy efficiency in buildings in Copenhagen and Madrid by relating them to the overall understandings of for instance political barriers or market barriers.

2.6 DEFINING THE PROBLEMS

RITTEL AND WEBBER

In order to define the barriers related to the energy efficiency paradox in buildings, the thesis includes the typology of Tame and Wicked problems, which was introduced by Rittel and Webber in their article: *Dilemmas in a general theory of planning (1973)*. The use of Tame and Wicked problems has been included in many other bodies of literature and this thesis extends the typology to leadership and management theories, as well as group culture theory, as a means to react to any defined problems or barriers identified through the empirical data from Copenhagen and Madrid, which will be presented in the next chapters of the thesis.

However, staying the in the context of this chapter, Rittel and Webber's typology is also relevant to the thesis in terms of their focus on aspect of planners, drawing a distinction between planning and science and arguing that the former is a wicked problem and the latter is a tame one: *The kind of problems that planners deal with – societal problems – are inherently different from the problems that scientists and some perhaps some classes of engineers deal with. Planning problems are inherently wicked. As distinguished from problems in the natural sciences, which are definable and separable and may have solutions*

that are findable, the governmental planning – and especially those of social or policy planning – are ill-defined…" (Rittel & Webber, 1973: 160).

Regardless of the validity surrounding the distinction between planning and science, something that has been challenged by Farrell and Hooker and will be discussed in this chapter as well, the typology of tame and wicked remains both relevant and interesting because it can be related to the barriers of energy efficiency in buildings, for instance by relating it to the policy making challenges of planning within energy efficiency, as also evident in the following quote: *A great many barriers keep us from perfecting such a planning/governing system: theory is inadequate for decent forecasting; our intelligence is insufficient to our tasks; plurality of objectives held by pluralities of politics makes it impossible to pursue unitary aims; and so on. (Rittel & Webber, 1973: 160).*

As illustrated above the difficulties of implementing planning/governing systems, for instance that of global energy efficiency, is because of barriers such as lack of resources, limited knowledge and capacity, complexity and different understandings of the same problem. These areas fit well with the thesis objective to investigate if there is evidence of barriers related to energy management in the building sector; if challenges exist to define the problem of the efficiency gap; if there are different interpretations according to each stakeholder; if there are unintended consequences regarding renewable energy sources; if solutions are more or less useful but not good or bad; if the problem is a symptom of another problem, etc. However these barriers may or may not be evident, it is the notion of the thesis that traditional policy-making and modifying administrative approaches are not capable to solve these problems effectively. (Rittel & Webber, 1973; Pollitt, 2015)

FARREL AND HOOKER

Rittel and Webber's work on tame and wicked problems is based on 10 characteristics, which intend to demonstrate that wicked problems are distinctly different from tame problems because they have certain constraints, with the purpose of creating a distinction between science and planning. This distinction has been challenged by Farrel and Hooker in their article: Design, science and wicked problems (2013), who argue that one can in fact not make the claim that science is governed by tame problem solving, and instead propose a new typology for problem solving based on three conditions of the problem situation that encompass all of the 10 characteristics proposed by Rittel and Webber: 1) Finitude, 2) Complexity and 3) Normativity.

Farrel and Hooker argue that it is *the depth and extent of this methodological challenge that ultimately constitutes the wickedness of a problem. The reduction to just three conditions produces a much clearer concept of wickedness that, in turn, enables a sharply delineated critical comparison of design and science problems. (Farrel & Hooker, 2013: 686)*

This means that Farrel and Hooker distinguish between degrees of wickedness based on the depth and extent of their three conditions; if the problem situation has no depth and/or extent it is a tame problem, and the more depth and extent, the more wicked the problem situation becomes.

As regards Finitude, the authors define it as the limitation of the human mind to acquire full knowledge of the world around us, thus limiting our capacity to make the right decision due to ignorance of the problem in question: *An immediate expression of our finitude is our ignorance: if we had unlimited cognitive capacities and resources then we would not be ignorant. As it is, we are ignorant, not just of the facts and true theories, but of methods for validly establishing these, the concepts required to specify them and the criteria for correctly deciding such things. Consequently, whenever a problem situation is characterised by such deep ignorance, or when a problem situation must be resolved but the available resources (including time) are finite and insufficient for an optimal solution, to that extent the problem at hand can be considered to be a wicked problem. This first condition is the most important; we contend that it is a necessary condition for wickedness. (Farrel & Hooker: 2018: 686)*

As regards Complexity, the authors explain it by highlighting the web of connections that make up any given system or structure, illustrating how difficult it can be to change one aspect of the system because it automatically affects other parts of the system due to the complexity and interconnectivity: *Every aspect of our world is characterisable as interactions between partially nested hierarchies of complex systems having multiple feedback and feedforward loops where multiple interactions among systems typically have far-reaching consequences across many functional levels, such interactions causing others in cascades that spread in unpredictable, irreversible, history- dependent ways throughout their domains. This complex-systems nature of the world has two general kinds of consequences relevant here. (A) It will often be impossible to disentangle the consequences of specific actions from those of other co-occurring interactions. (B) The outcomes of processes are difficult to predict, amplifying our ignorance and exacerbating the limits imposed by finite resources. (Farrel & Hooker: 2018: 686)*

As regards Normativity, the authors explain as the constraining force of embedded understandings through norms and values: *Human values and norms can become inextricably intertwined with problem formulation and problem resolution. Notoriously, values and norms are often in conflict both between agents and even within an agent's normative commitments and require sufficient resolution through compromise to permit a coherent and practicable problem resolution. (Farrel & Hooker: 2018: 686)*

2.7 HOW TO REACT TO WICKED PROBLEM

GRINT

The overall purpose of Grint's articles is to help problem solvers frame a given situation by categorizing problems into three types: *Tame, Wicked* and *Critical problems* and drawing relevant approaches by associating them to three forms of legitimate authorities - *management, leadership and command*: "*Perhaps the first thing we need to do is consider a contextualized typology of problems. Management and Leadership, as two forms of authority rooted in the distinction between certainty and uncertainty, can be related to Rittell and Webber's (1973) typology of Tame and Wicked Problems. (Grint, 2005: 1473)*

Grint highlights the fact that even though a *Tame problem* may seem complicated, it nevertheless has limited uncertainties, which means that it is resolvable and it is likely to have occurred before, what can be called "de-ja vu", and is therefore associated with management: *The manager's role, therefore, is to provide the appropriate processes to solve the problem. Examples would include: timetabling the railways, building a nuclear plant, training the army, planned heart surgery, a wage negotiation – or enacting a tried and trusted policy for eliminating global terrorism. (Grint 2005: 1473).*

In contrast, a *Wicked problem* is novel and any apparent solution often generates other problems', and there is no 'right' or 'wrong' answer, but there are better or worse alternatives, what can be called "vu-ja de", and is thus associated with leadership: *Examples would include: developing a transport strategy, or an energy strategy, or a defence strategy, or a national health system or an industrial relations strategy (Grint 2008:12).*

A *Critical problem* is characterized by being self-evident and theoretically lacks the uncertainties what needs to be done, and thus a *Critical problem* is associated with the *command* authority type: *Here there is virtually no uncertainty about what needs to be done – at least in the behaviour of the Commander, whose role is to take the required decisive action – that is to provide the answer to the problem, not to engage processes (management) or ask questions (leadership). (Grint 2005: 1474).*

The figure below shows the typology: The vertical axis denotes the degree of uncertainty to the problem in questions, and the horizontal axis denotes the corresponding behaviour of authority best suited as a response. Using this figure, Grint emphasizes that: '*the more decision-makers constitute the problem as Wicked and interpret their power as essentially Normative, the more difficult their task becomes, especially with cultures' (Grint, 2008:11).*

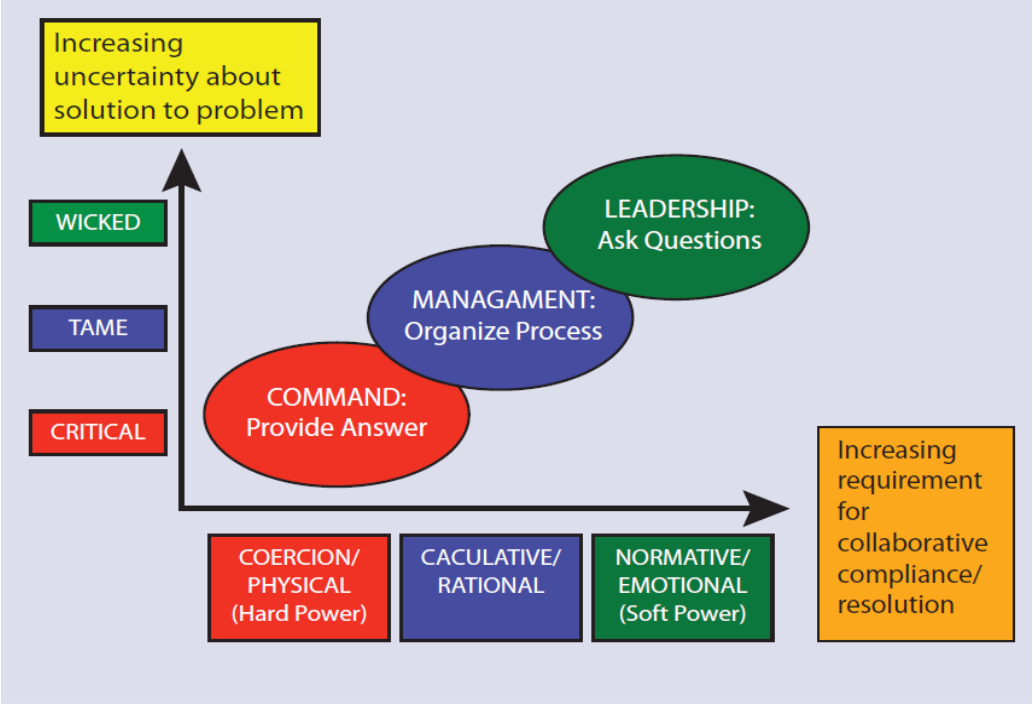


Figure 5. Typology of problems, power and authority (Grint, 2008).

DOUGLAS

Grint starts building his proposal by applying Mary Douglas's Grid-group cultural theory to problem solving.

Grid-group Cultural Theory can be explained as a model with two dimensions of sociality measure: *group* and *grid*. The group dimension describes tires of society or people's connections, whereas the grid dimension relates to peoples indifferences and how people take on different roles. The vertical (grid) and horizontal (group) axes compose a two-by-two table and construct four components (*Figure 2*). These four components represent four cultural archetypes: *Fatalism, Hierarchy, Individualism* and *Egalitarians.* The Fatalist culture is characterised by weak bonds between people and varied interpersonal differences, and this type tends to include isolated individuals with apathy style. The Hierarchy or collectivist culture is described as a group with strong bonds between people and varied interpersonal differences. Individualism implies significant similarity between people but with low bond between them, and this type represents market freedom. The final is the Egalitarians category, in which people have strong bonds and similarities between each other. The Egalitarian culture is described as an ideal utopia for small groups with high community sense.

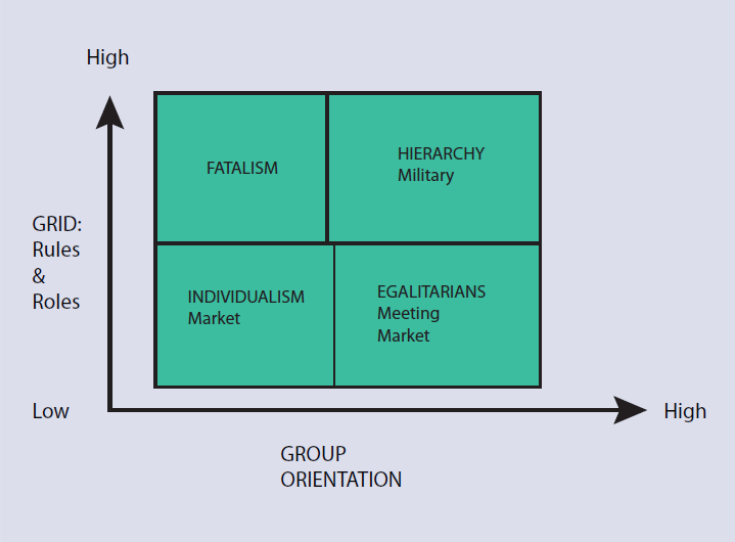


Figure 6. Grid-group cultural model (Grint, 2008).

By applying this model as modes of understanding to how the world deals with problems, Grint proves that it will answer only Tame or Critical problems, but not Wicked problems. Each group has its own approach, a so-called Elegant solution**.** Hierarchists are good at decision-making, but weak an innovations; Egalitarians are good at generating debate, but fail at reaching decisions; Individuals are innovative but once the market fails they lose everything. To explain, the author gives an example: *Individualists can solve the problem of decreasing carbon emissions from cars – a Tame problem open to a scientific solution, but they cannot solve global warming – a Wicked Problem. Egalitarians can help ex-offenders back into the community – a Tame Problem – but they cannot solve crime – a Wicked Problem. And Hierarchists can improve rule enforcement for the fraudulent abuse of social services – a Tame Problem – but they cannot solve poverty – a Wicked Problem' (Grint, 2008:14)* He

states, that Wicked problems cannot be solved by Elegant approaches because they lie outside and across cultures. Each elegant solution has weaknesses and addresses only element of Wicked problems.

Approaching Global warming was taken as an example to illustrate that each single elegant approach is isolated and therefore does not tackle the bigger complex problem (figure 3).

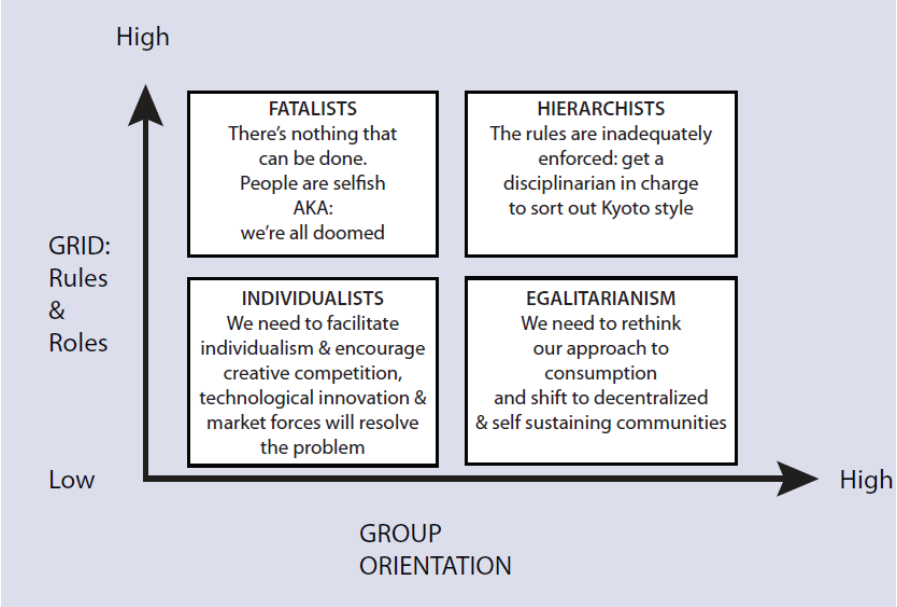


Figure 7. Elegant solution approach (Grint, 2008).

No single solution addresses the complexity of bigger picture and would not provide an answer to climate change. Therefore, the idea is to combine all modes of understanding into one system and spur collaboration between the individual approaches – Clumsy Solution. The figure below illustrates the clumsy solution approach, which combines elements of three cultural types: individualists, hierarchists and egalitarians. (Figure 4).

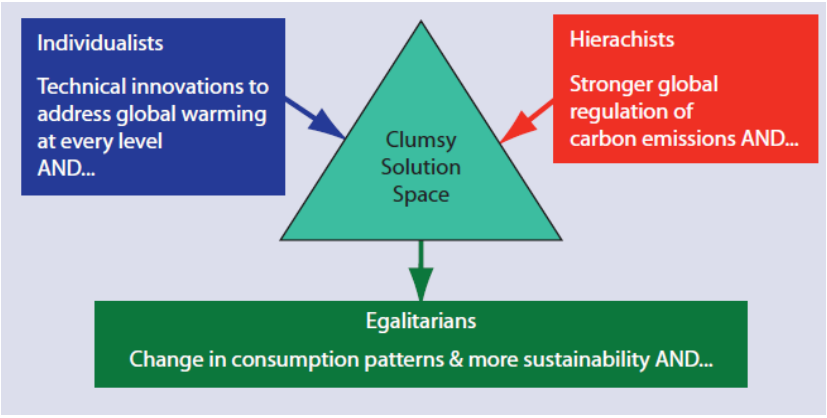


Figure 8. Clumsy solution approach (Grint, 2008).

In the context of the thesis, dealing with the matter of global EE is assumed to be a problem containing high degrees of wickedness, where simple solutions cannot be applied due to the cross-border diversity of stakeholders and actors involved in the building sector at various

stages and scales. The interdisciplinary approach found through the clumsy solutions approach may therefore be useful in order to link the cross-sectorial views represented by the different cultural types, since they all have a stake in this problem. Evidence from literature suggests that resolving Wicked Problem is attainable through a clumsy solution approach by engaging different organizations and sectors in win-win collaboration and establishing coordination between them.

The idea that 'wicked' environmental and social problems can be resolved with 'clumsy' solutions has been increasingly supported by empirical evidence (Ney & Verweij, 2015; Rayner, 2006). For instance, cultural theory was used to examine and understand stakeholders network (Perrault, 2014). By applying cultural theory to the climate change debates, literature also illustrates how the Kyoto Protocol has stagnated (Verweij, 2006). Creative collaboration has proven to be an essential tool for designing effective planning: governments must work together with the building and construction industry, NGO and civil society organizations, research and educational institutes, and most importantly, the public, to achieve the common goal of climate change mitigation.

METHODOLOGY

3. METHODOLOGY

3.1 ONTOLOGY AND EPISTEMOLOGY

The theoretical perspectives used to analyze and process the empirical data, leading towards the objectives of 1) understanding the problems related to EEB (discourse theory), 2) defining the problems related to EEB (tame/wicked theory) and 3) reacting to the problems of EEB (clumsy solution theory), are based on a social constructionist perspective. This means that language and language use, and therefore the creation of meaning through articulation, is what constitutes the reality of EEB by framing “the truth” in certain ways.

Furthermore, the contingency of language and meaning in a social constructionist perspective means that it is impossible to achieve absolute fixation of meaning. No knowledge can exist which claims to objectively mirror the objects that they claim to know something about. This means that the outcomes of the analysis, what the thesis defines are barriers to EEB, do not represent an objective truth since the outcomes themselves are discursive constructions.

Therefore, the findings of this analysis do not represent a “universal truth”, it is rather a truth within the specific area of investigation. In order to justify that that the findings of the analysis are relevant to the area of EEB, and that the findings go beyond simple coincidence, the analysis focuses on not only identifying the problems associated with one city, but chooses to analyze both Copenhagen and Madrid, and furthermore with the intent of analyzing if, how and where the two cities are related to each other.

The value of the findings in this thesis should not be based on their objectivity but instead in their capacity to prove how barriers to EEB in Copenhagen and Madrid, and the relation between these two cities, can become meaningful in the sense of overcoming them.

3.2 PRIMARY DATA

The qualitative interview method was selected as a primary source of empirical data in order to gain in-depth information. 17 interviews were conducted with selected actors in the EEB industry in Copenhagen and Madrid. A semi-structured method was applied for two reasons. From one hand, to unite the direction of the interview for multi-industry actors, while from the other hand, to avoid having a fully fixed structure and allow interviewees to investigate on relevant from their perspective insights. The interviewees were informed of the core of the research and context of the interview.

3.3 SECONDARY DATA

The selection of the secondary data is twofold. On the one hand, the sources were selected in order to build a European framework by using data, statistics and reports from official publications. On the other hand, to support primary data to build a more detailed analysis by using data from companies and organizations publications of interviewees.

3.4 CHOICE OF EMPIRICAL DATA

This chapter briefly introduces the actors that have been chosen to collect an empirical data. The implementation of EEB is dispersed over a wide area of stakeholders including municipalities, private businesses, NGOs and Civil Society actors, research and educational institutions. The actors were chosen from these four societal areas in order to create a comprehensive objective picture of the problems in EEB.

GOVERNMENT REPRESENTATIVES

The political environment plays an important role in implementing EEB. To have an in-depth understanding of the problems of EEB it is important to consider different levels of political decision arrangements from State Government, as this level is responsible of implementation of Europeans requirements, to municipal or community level where local implementation takes place.

MARKET REPRESENTATIVES

Different sectors associated with the EEB market demands attention as they contribute to the overall picture of the EEB situation: technical, economical, communication and network. For the research, real estate developers, architect studios, energy agencies and consultancies, sustainability and construction media representatives were interviewed.

RESEARCH INSTITUTION REPRESENTATIVES

Research institutions affect the field of innovation of EE and therefore play an import role in conducting this research. They contribute to the development of research and development of EE, they test and validate solutions, conduct analysis and illustrate statistics, highly responsible for educating people in the field.

NGO REPRESENTATIVES

Environmental NGOs and green transition activists' movements have an important input as they interested in energy reduction consumption, spreading the knowledge, targeting the awareness and motivating communities and the public in general.

Table 1. Experts in Copenhagen

Table 2. Experts in Madrid

COPENHAGEN			
INTERVIEWEE #	NAME	ORGANIZATION	POSITION
GOVERNMENT REPRESENTATIVES			
#6	Annette Egetoft	Copenhagen Municipality *Københavns Kommune*	Project leader
#3	Steen Olesen	Hooje-Taastrup Municipality *Høje-Taastrup Kommune*	Project leader
#1	Jacob Høgh	Centre for Global Cooperation under Danish Energy Agency	Policy Advisor
MARKET REPRESENATIVE			
#7	Kristian Henningsen	Confederation of Danish Industry *Dansk Industri*	Chief consultaunt
#9	Anders Dyrelund	Consulting Group Ramboll	Senior Market Manager in Energy Planning and Production
#8	Dan Ho Howis Lauritsen	Branding organization State of Green	Head of Communication
RESEARCH INSTITUTION			
#4	Jesper Ole Jensen	Danish Building Research Institute, Aalborg University	Senior Researcher, PhD, Department of Town, Housing and Property
#5	Ole Michael Jensen	Danish Building Research Institute, Aalborg University	Senior Researcher, Department of Energy Performance, Indoor Environment and Sustainability of Buildings
#10	Karl Sperling	Institute of Planning, Aalborg University	Associate Professor
NON-GOVERNMENTAL ORGANIZATION			
#2	Tommy Olsen	Non-governmental Organization Gate 21	Consultant

MADRID			
INTERVIUWEE #	NAME	ORGANIZATION	POSITION
GOVERNMENT REPRESENTATIVES			
#13	Dr. Claudio D. Miguez	IDEA (The Institute for Diversification and Saving of Energy) *Instituto para la Diversificación y Ahorro de la Energía*	Manager at Planning and Studies Department
#15	Dr. Arch. Almudena Fuster	Municipal Housing Enterprise *Empresa Municipal de la Vivienda y Suelo-EMVS*	Chief of the Department of Innovation, Associate Professor at the University of Alcala de Henares
MARKET REPRESENATIVE			
#12	Jesús Román	Architecture Studio *Rafael de la Hoz Arquitectos*	Project Manager
#16	Inés Leal	Consulting Group *Grupo Tecma Red*	Editorial Director
RESEARCH INSTITUTION			
#11	Beatriz Arranz	Research Institute in Construction *Eduardo Torroja*	Researcher in Energy efficiency through glazing, simulations of daylight
#17	Felix Avia Aranda	CIEMAT (Center for Energy, Environmental and Technological Research*) Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas*	Expert in Renewable Energy, President of the European Academy of Wind Energy (EAWE)
NON-GOVERNMENTAL ORGANIZATION			
#14	Mr. Rodrigo Irurzun	Non-governmental Organization Ecology in Action *Ecologistas en Acción*	Civil Engineer, Responsible for Energy Division

3.5 PROCESSING THE EMPIRICAL DATA

After transcripting and reading all the interviews, the statements were grouped into three core categories: *Institutional Problems, Market Problems* and *End-User Problems.* Under the each category, comments were distinguished between more specific areas. Following the areas, based on primary and secondary data barriers were formulated.

The following step was to evaluate and code the barriers in terms of their problem nature. Based on theoretical foundation problems, they were categorized into *Wicked, Tame* and *Critical.* In order to explain the logic of the coding each problem evaluation is briefly described.

Based on initial coding of the empirical data, common barriers for both cases problems are determined. Consequently, they are being examined from lens of wicked problem in order to test the hypothesis.

In the Discussion and Recommendation chapter, the approaches to the problem are suggested.

CASE STUDIES

4. CASE STUDIES. DATA ANALYSIS

4.1 PART I. CITIES

The following chapter consists of two parts and provides research on case studies based on primary and secondary data. First, to prepare the canvas for further exploration of problems in each case, the chapter gives an overview on energy efficiency of the building sector regulations on a European level and explains the selection of case cities. The consecutive part draws upon an introduction to the current situation and regulatory framework specifically in each selected case. The second part of the chapter explores the problems and the barriers that continue to persist in each city. 18 Interviews with key actors were carried out to identify which factors create the gap and hold back energy efficiency in residential buildings. Discourse analysis is used to make sense of what is being said by the interviewees regarding the problems and the barriers, where their quotes are used to express the actual talk and articulation on the barrier in question, what is understood as the little d discourse or the vocabulary through which the barriers are expressed.

Based on these articulations, the barriers are then analysed and grouped according to the overall meanings on the subject of EEB, what is understood as the big D discourse or the dictionary from which the vocabulary is chosen. The understanding of the overall meanings related to EEB is identified through the secondary data, for instance by analysing facts and content from reports, as well by the grouping of common elements identified by the interviewees. From an overall perspective, this has led me to distinguish findings in terms of three groups: Institutional, Marketing and End-User failures. These three groups will form the basis of the overall structure for the barriers related to EEB.

4.1.1 EUROPEAN BUILDING STOCK AND POLICY FRAMEWORK

According to the International Energy Agency, the residential sector consumed 23% of the total energy consumption in 2011, increased by 35% since 1990 because of the growing housing density and profound household applicants. European Union analyses show that the building sector is responsible for approximately 40% of energy consumption and of CO2 emissions. In 2013, the constructed area in EU was 25 billion m2 with residential share around 75% (Executive Agency for Competitiveness and Innovation, 2013). The building sector is defined as a key player in achievement EU energy targets as it has greatest potentials for energy savings.

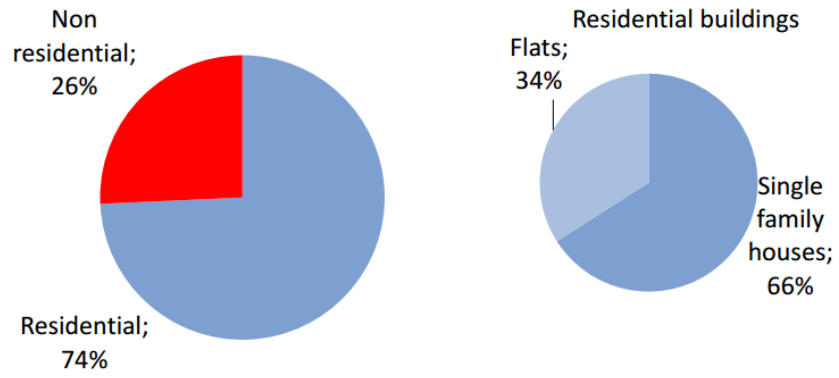


Figure 9. Total floor area of buildings by type across EU, 2012. (ODYSSEE-MURE, 2015).

Climate conditions and socio-economic situation contribute the most on lifestyle and therefore residential energy consumption pattern. The figure below demonstrates the difference in energy consumption, for example between countries in the North and South.

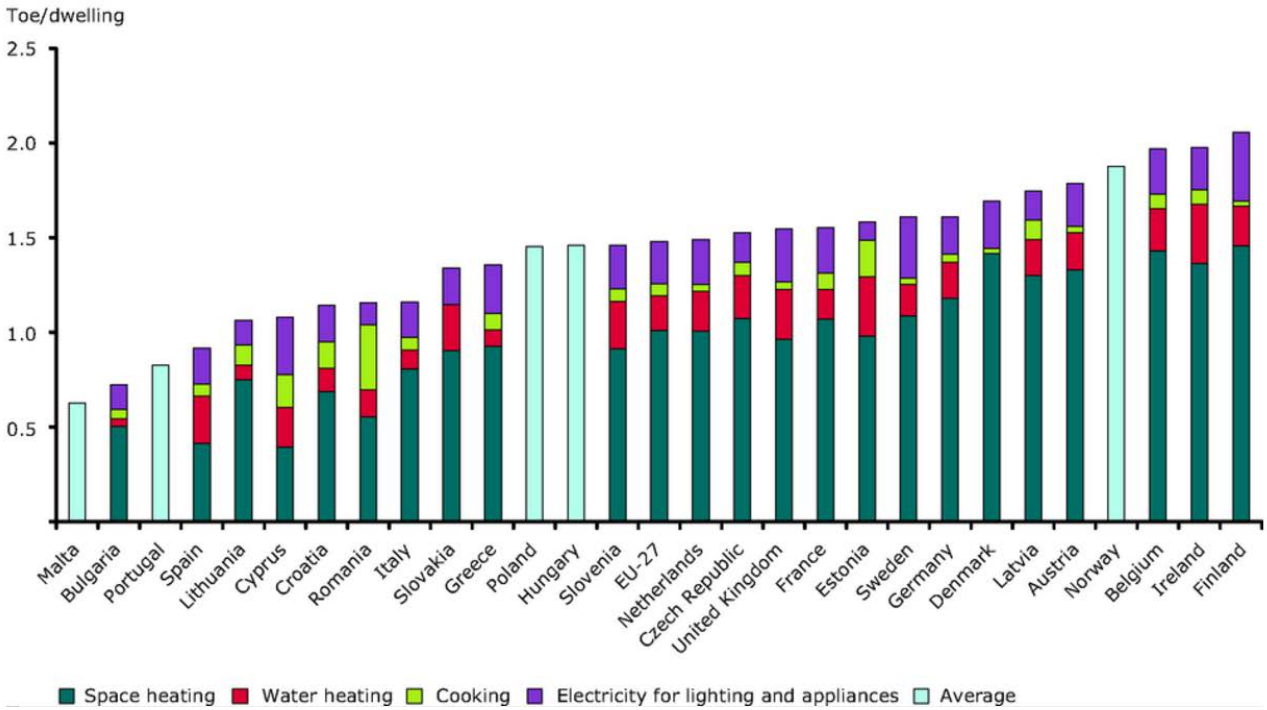


Figure 10. Energy consumption by end use per dwelling,2010 (Economidou et al., 2011)

In 2013, there were 25 billion m2 of constructed area in the EU, of which 74% were residential and 26% a mix of commercial area (EACI, 2013). Single-family houses represent 66% of residential floors while 34% is being used for the apartments. According to BPIE research current, European building stocks have essential share of building from 50 to more than 100 years old (Economidou et al., 2011). Almost half of residential buildings have been constructed before the 1960s when energy-efficient building regulations were very limited. In many countries, the construction boom during 1961-1990 led housing stock to grow double.

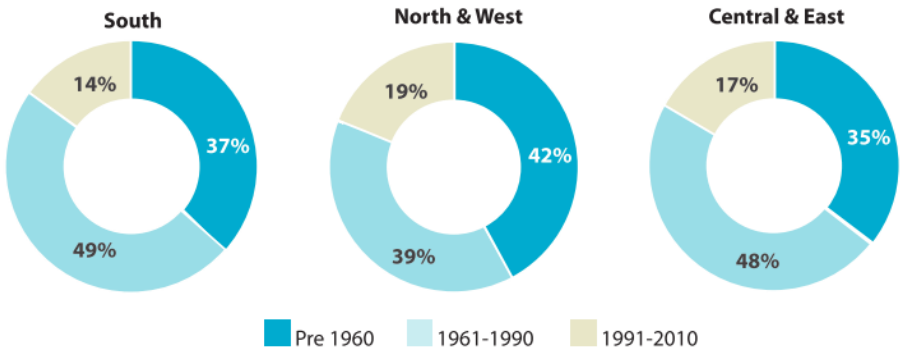


Figure 11. Age categorization of housing stock in Europe. (Economidou et al., 2011)

EE is a key priority on the EU level. The European Union adopted its 'Energy 2020' strategy where it has set a roadmap to achieve a 20% reduction of greenhouse gas emissions, 20% energy savings and 20% share of renewables by 2020.

One of the main legislative instruments is a Directive on energy End-Use Efficiency and Energy Services (ESD) from 2006, which set energy savings target for a decade and required Member States to develop a National Energy Efficiency Action Plan (NEEAP). Another relevant document is an Energy Efficiency Directive (EED) from 2011. The policy concept of EED addresses EE obligations of Member States, annual renovation of the buildings, industries by variety of incentives for companies, monitoring energy generation capacity and consumer end. The Energy Performance of Buildings Directive (EPBD) is the major legislative instrument at EU level aimed to achieve energy performance in buildings. EPBD came into force in 2002, had a recast in 2010 and will be updated in 2017 (European Commission, 2010). Under this Directive, the Member States must apply minimum requirements in energy performance of new and existing buildings, ensuring the certification of their energy performance and requiring the regular inspection of boilers and air conditioning systems in buildings. It is obligatory to establish cost-optimal minimum energy performance requirements, ensuring that the Energy Performance Certificate (EPC) is included in all advertisements for sale or rental and by requiring that all existing buildings meet certain efficiency levels when they undergo a major renovation (EACI, 2013). It also requires Member States by the end of 2020 (2018 for public buildings sector) to make all new buildings are nearly zero-energy (NZB).

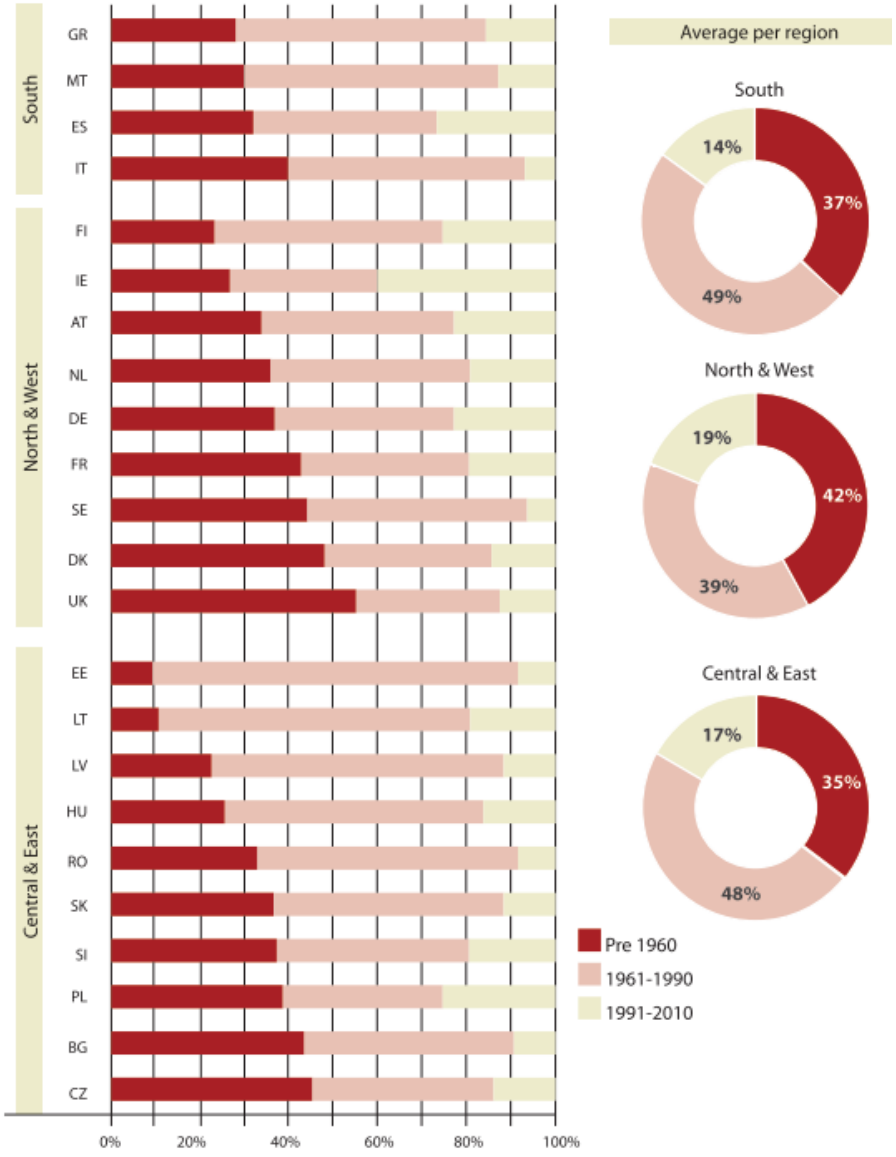


Figure 12. Age profile of residential floor space. (Economidou et al., 2011)

As there is some freedom in the way of implementing the directive, the European Commission launched a number of programs, initiatives and portals that aim to support the transposition and implementation of the new Directives and even to foster action beyond (EACI, 2013). For example, Concerted Action via the Intelligent Energy Europe program, or Energy-efficient Buildings Key Action. *When implementing a new Directive EU on one side, it pushes the legal aspect, and on the other side it helps to allocate financial resources to help the market and research and to adapt what they are asking* (interviewee #16).

Figure 13. Support with EPBD implementation (Cabau, 2011).

Following the GHG reduction targets, each building needs to demonstrate very low carbon emission levels and less energy consumption. Therefore, most European buildings have to be improved regarding to current energy consumption and the installation of renewables. However, the use of renewable energies in the building sector remains a significant challenge. As Europe has adopted an ambitious vision for all new buildings to be 'nearly zero-energy' buildings by the 2020 (by the end of 2018 for public buildings), Member States have to create a national action plans for increasing the number of 'nearly zero-energy buildings', including policies and measures to stimulate the refurbishment of the existing building stock (EACI, 2013). The programs of increasing energy efficiency need to use strong arguments to encourage both the private and public sectors to take more interest in improving energy efficiency. Moreover, the building sector is characterized by the fragmented involvement of different actors through design, construction, commissioning and operational process. Therefore, it is a big challenge to change the mind-set concerning buildings among the actors.

Improving energy efficiency is a long-term policy commitment. To sustain the buildings sector, policies must be effective not only for a few years but for decades. One can argue that energy efficiency initiatives is hard to prioritize in times when more immediate agenda is arising such as solving financial crisis, wars and budget debts. It is important to underline that improved energy efficiency could make a positive contribution to solutions in those policy areas like economic and social problems (Economidou et al., 2011).

4.1.2 SELECTION CRITERIA OF THE CASE STUDIES

The accomplishment of the energy efficiency goals differs among European countries due to the diversity of existing building stock, ambitiousness of the new energy efficiency requirements for construction, renovation and characteristics of national legislations. Moreover, when looking at the energy performance of the buildings it is important to take into account conditions such as urban planning, climate, social-economic situation, etc.

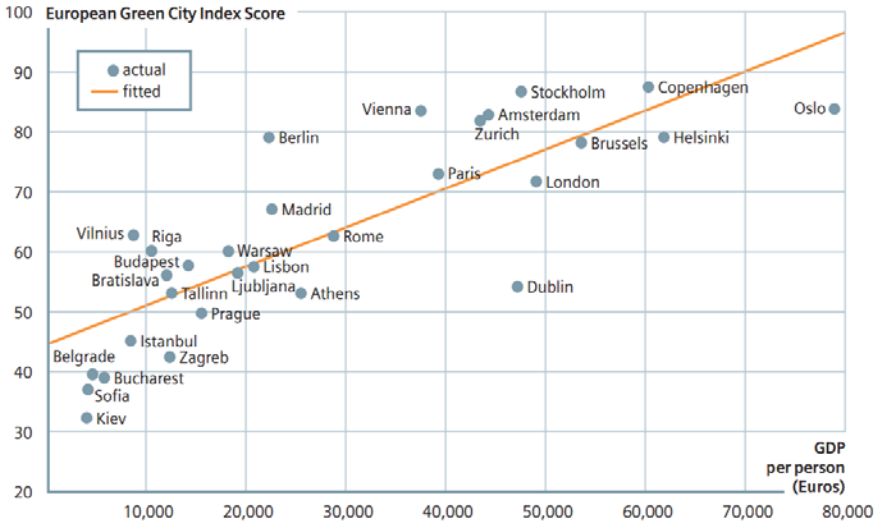


Figure 14. The link between wealth and environmental performance. (Economist Intelligence Unit, 2009).

The table below is a result of the European Green City Index research project that measured and rated the environmental performance of 30 European cities from 30 countries (Economist Intelligence Unit, 2009). The methodology was developed and project was conducted by the Economist Intelligence Unit and sponsored by Siemens. The table ranks and demonstrates each city's effectiveness in eight indexes of environmental performance.

Overall

	City	Score
1	Copenhagen	87,31
2	Stockholm	86,65
3	Oslo	83,98
4	Vienna	83,34
5	Amsterdam	83,03
6	Zurich	82,31
7	Helsinki	79,29
8	Berlin	79,01
9	Brussels	78,01
10	Paris	73,21
11	London	71,56
12	Madrid	67,08
13	Vilnius	62,77
14	Rome	62,58
15	Riga	59,57
16	Warsaw	59,04
17	Budapest	57,55
18	Lisbon	57,25
19	Ljubljana	56,39
20	Bratislava	56,09
21	Dublin	53,98
22	Athens	53,09
23	Tallinn	52,98
24	Prague	49,78
25	Istanbul	45,20
26	Zagreb	42,36
27	Belgrade	40,03
28	Bucharest	39,14
29	Sofia	36,85
30	Kiev	32,33

CO_2

	City	Score
1	Oslo	9,58
2	Stockholm	8,99
3	Zurich	8,48
4	Copenhagen	8,35
5	Brussels	8,32
6	Paris	7,81
7	Rome	7,57
8	Vienna	7,53
9	Madrid	7,51
10	London	7,34
11	Helsinki	7,30
12	Amsterdam	7,10
13	Berlin	6,75
14	Ljubljana	6,67
15	Riga	5,55
16	Istanbul	4,86
=17	Athens	4,85
=17	Budapest	4,85
19	Dublin	4,77
20	Warsaw	4,65
21	Bratislava	4,54
22	Lisbon	4,05
23	Vilnius	3,91
24	Bucharest	3,65
25	Prague	3,44
26	Tallinn	3,40
27	Zagreb	3,20
28	Belgrade	3,15
29	Sofia	2,95
30	Kiev	2,49

Energy

	City	Score
1	Oslo	8,71
2	Copenhagen	8,69
3	Vienna	7,76
4	Stockholm	7,61
5	Amsterdam	7,08
6	Zurich	6,92
7	Rome	6,40
8	Brussels	6,19
9	Lisbon	5,77
10	London	5,64
11	Istanbul	5,55
12	Madrid	5,52
13	Berlin	5,48
14	Warsaw	5,29
15	Athens	4,94
16	Paris	4,66
17	Belgrade	4,65
18	Dublin	4,55
19	Helsinki	4,49
20	Zagreb	4,34
21	Bratislava	4,19
22	Riga	3,53
23	Bucharest	3,42
24	Prague	3,26
25	Budapest	2,43
26	Vilnius	2,39
27	Ljubljana	2,23
28	Sofia	2,16
29	Tallinn	1,70
30	Kiev	1,50

Buildings

	City	Score
=1	Berlin	9,44
=1	Stockholm	9,44
3	Oslo	9,22
4	Copenhagen	9,17
5	Helsinki	9,11
6	Amsterdam	9,01
7	Paris	8,96
8	Vienna	8,62
9	Zurich	8,43
10	London	7,96
11	Lisbon	7,34
12	Brussels	7,14
13	Vilnius	6,91
14	Sofia	6,25
15	Rome	6,16
16	Warsaw	5,99
17	Madrid	5,68
18	Riga	5,43
19	Ljubljana	5,20
20	Budapest	5,01
21	Bucharest	4,79
22	Athens	4,36
23	Bratislava	3,54
24	Dublin	3,39
25	Zagreb	3,29
26	Prague	3,14
27	Belgrade	2,89
28	Istanbul	1,51
29	Tallinn	1,06
30	Kiev	0,00

Transport

	City	Score
1	Stockholm	8,81
2	Amsterdam	8,44
3	Copenhagen	8,29
4	Vienna	8,00
5	Oslo	7,92
6	Zurich	7,83
7	Brussels	7,49
8	Bratislava	7,16
9	Helsinki	7,08
=10	Budapest	6,64
=10	Tallinn	6,64
12	Berlin	6,60
13	Ljubljana	6,17
14	Riga	6,16
15	Madrid	6,01
16	London	5,55
17	Athens	5,48
18	Rome	5,31
=19	Kiev	5,29
=19	Paris	5,29
=19	Vilnius	5,29
=19	Zagreb	5,29
23	Istanbul	5,12
24	Warsaw	5,11
25	Lisbon	4,73
26	Prague	4,71
27	Sofia	4,62
28	Bucharest	4,55
29	Belgrade	3,98
30	Dublin	2,89

Water

	City	Score
1	Amsterdam	9,21
2	Vienna	9,13
3	Berlin	9,12
4	Brussels	9,05
=5	Copenhagen	8,88
=5	Zurich	8,88
7	Madrid	8,59
8	London	8,58
9	Paris	8,55
10	Prague	8,39
11	Helsinki	7,92
12	Tallinn	7,90
13	Vilnius	7,71
14	Bratislava	7,65
15	Athens	7,26
=16	Dublin	7,14
=16	Stockholm	7,14
18	Budapest	6,97
19	Rome	6,88
20	Oslo	6,85
21	Riga	6,43
22	Kiev	5,96
23	Istanbul	5,59
24	Lisbon	5,42
25	Warsaw	4,90
26	Zagreb	4,43
27	Ljubljana	4,19
28	Bucharest	4,07
29	Belgrade	3,90
30	Sofia	1,83

Waste and land use

	City	Score
1	Amsterdam	8,98
2	Zurich	8,82
3	Helsinki	8,69
4	Berlin	8,63
5	Vienna	8,60
6	Oslo	8,23
7	Copenhagen	8,05
8	Stockholm	7,99
9	Vilnius	7,31
10	Brussels	7,26
11	London	7,16
12	Paris	6,72
13	Dublin	6,38
14	Prague	6,30
15	Budapest	6,27
16	Tallinn	6,15
17	Rome	5,96
18	Ljubljana	5,95
19	Madrid	5,85
20	Riga	5,72
21	Bratislava	5,60
22	Lisbon	5,34
23	Athens	5,33
24	Warsaw	5,17
25	Istanbul	4,86
26	Belgrade	4,30
27	Zagreb	4,04
28	Bucharest	3,62
29	Sofia	3,32
30	Kiev	1,43

Air quality

	City	Score
1	Vilnius	9,37
2	Stockholm	9,35
3	Helsinki	8,84
4	Dublin	8,62
5	Copenhagen	8,43
6	Tallinn	8,30
7	Riga	8,28
8	Berlin	7,86
9	Zurich	7,70
10	Vienna	7,59
11	Amsterdam	7,48
12	London	7,34
13	Paris	7,14
14	Ljubljana	7,03
15	Oslo	7,00
16	Brussels	6,95
17	Rome	6,56
18	Madrid	6,52
19	Warsaw	6,45
20	Prague	6,37
21	Bratislava	5,96
22	Budapest	5,85
23	Istanbul	5,56
24	Lisbon	4,93
25	Athens	4,82
26	Zagreb	4,74
27	Bucharest	4,54
28	Belgrade	4,48
29	Sofia	4,45
30	Kiev	3,97

Environmental governance

	City	Score
=1	Brussels	10,00
=1	Copenhagen	10,00
=1	Helsinki	10,00
=1	Stockholm	10,00
=5	Oslo	9,67
=5	Warsaw	9,67
=7	Paris	9,44
=7	Vienna	9,44
9	Berlin	9,33
10	Amsterdam	9,11
11	Zurich	8,78
12	Lisbon	8,22
=13	Budapest	8,00
=13	Madrid	8,00
=15	Ljubljana	7,67
=15	London	7,67
17	Vilnius	7,33
18	Tallinn	7,22
19	Riga	6,56
20	Bratislava	6,22
=21	Athens	5,44
=21	Dublin	5,44
=23	Kiev	5,22
=23	Rome	5,22
25	Belgrade	4,67
26	Zagreb	4,56
27	Prague	4,22
28	Sofia	3,89
29	Istanbul	3,11
30	Bucharest	2,67

Table 3. Result of European Green City Index research project (Economist Intelligence Unit, 2009).

Based on the outcome of the project, two cities with a large gap in performance and located in different parts of Europe with different climate, planning characteristics and socio-economic level - Copenhagen and Madrid - were selected as case studies.

4.1.3 COPENHAGEN

CITY PROFILE

Copenhagen city had a population of 559,440 people in 2013 (Eurostat, 2015). Although it is close to 10% of Denmark's population it is defined as rather small city by European standards. However, it is the country's capital and the main business and financial node, housing a big share of international companies' headquarters in Western Europe. Copenhagen metropolitan economy grew by 25% from 1993 to 2010. The greenhouse gas emissions (transport, heat and electricity sector) decreased by 40% in the same period (C40, 2013).

In the European Green City Index research, Copenhagen achieves the highest ranking with a score of 87.31 out of 100. The city demonstrates high performance in all categories and leading case for the environmental governance category (Economist Intelligence Unit, 2009).

Figure 15. Copenhagen performance by European Green City Index research (Economist Intelligence Unit, 2009).

Denmark's energy policy succeeds at reducing the country's dependence on coal and oil, instead being in favour of natural gas and renewable energy sources. The Danish government set up the aim to increase the share of renewable energy to 30% of the total energy

consumption by 2025. It is the Government's long-term objective to of being free of fossil fuels by 2050, and an important element in this objective is improving energy efficiency (Danish Energy Agency, 2014). According to Danish Energy Agency between 30 and 40% of total Danish energy consumption is used for heating, ventilation and lighting in building (Danish Energy Agency, 2014). The potential for energy savings in the existing Danish building stock is around 70-75% up to 2050.

Copenhagen ranks forth in the buildings category in the European Green City Index (Economist Intelligence Unit, 2009). Despite the old housing stock, Danish new buildings are one of the most energy-efficient in the world. It is the lowest of the 30 cities in the survey -- consuming only 554 mega joules per m3 in the annual energy consumption of residential buildings, almost all of which in Danish capital are connected to district heating system.

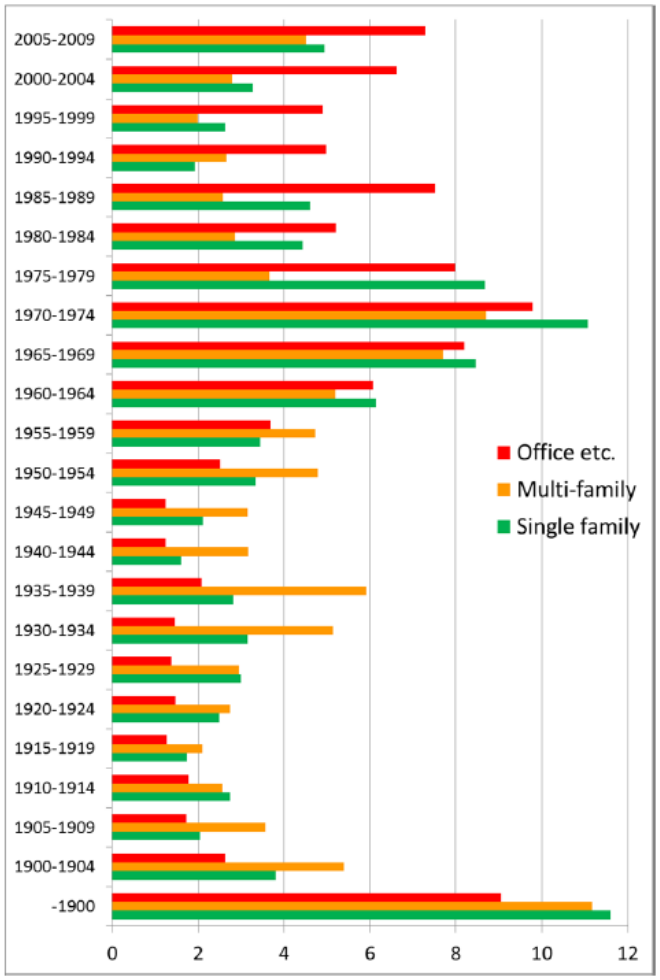


Figure 16. Construction year for the Danish building stock for each of the three lump building types (Economidou et al., 2011).

ENERGY SOURCES AND ENERGY SYSTEM

Denmark is known as leading state in green transition. Increasing energy efficiency by reducing energy consumption and depending on renewable sources of energy seems to be a priority for the country since energy crisis in 1970s.

Denmark chose early on to prioritize energy savings and a diversified energy supply, including use of renewable energy. A broad array of notable energy-policy initiatives were launched, including a focus on combined heat and electricity production, municipal heat planning and on establishing a more or less nation-wide natural gas grid. Furthermore, Denmark extensively improved the efficiency of the building mass and introduced an ambitious use of green taxes. A crucial element in accomplishing the 2050-vision of a transition to 100 % independence of fossil fuels will be that Denmark uses less energy by switching to more energy efficient technologies. Otherwise, economic growth will push up energy consumption and make it disproportionally expensive to expand the share of renewables in the energy supply (interviewee #8).

The international energy crisis in 1973 caused to raise the energy prices and consequently pushed Denmark to focus on alternative sources of energy to become independent from fuel and therefore, led a strong drive towards development of district energy systems. Today over 60 per cent of residential buildings in Denmark get the heat and electricity through combined heat and power production with efficiency rate up to 92%. Greater Copenhagen has integrated a district heating system [1], in which heat is being produced by waste incinerators and power plants. (Steam & New, 2011).

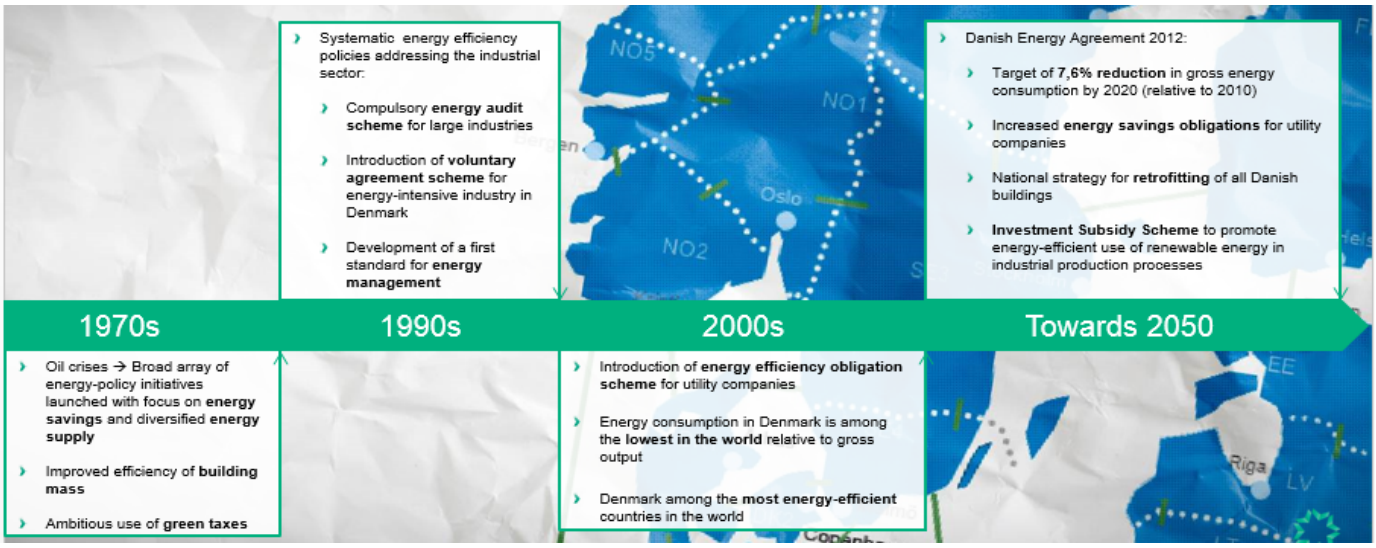


Figure 17.Timeline of sustainable energy path of Denmark. (State of Green, 2012)

In Denmark, the share of renewable energy is raising with share in the wind power, wood pellets, wood waste and forestry wood chips. Calculation by Danish Energy Agency applying EU method, renewable energy accounted for 25.8 % of energy consumption in 2001. At the same time, production of electricity based on renewable energy accounted for 43.1 % of domestic electricity supply in 2012, of which wind power contributed 29.8 % (Danish Energy Agency, 2014).

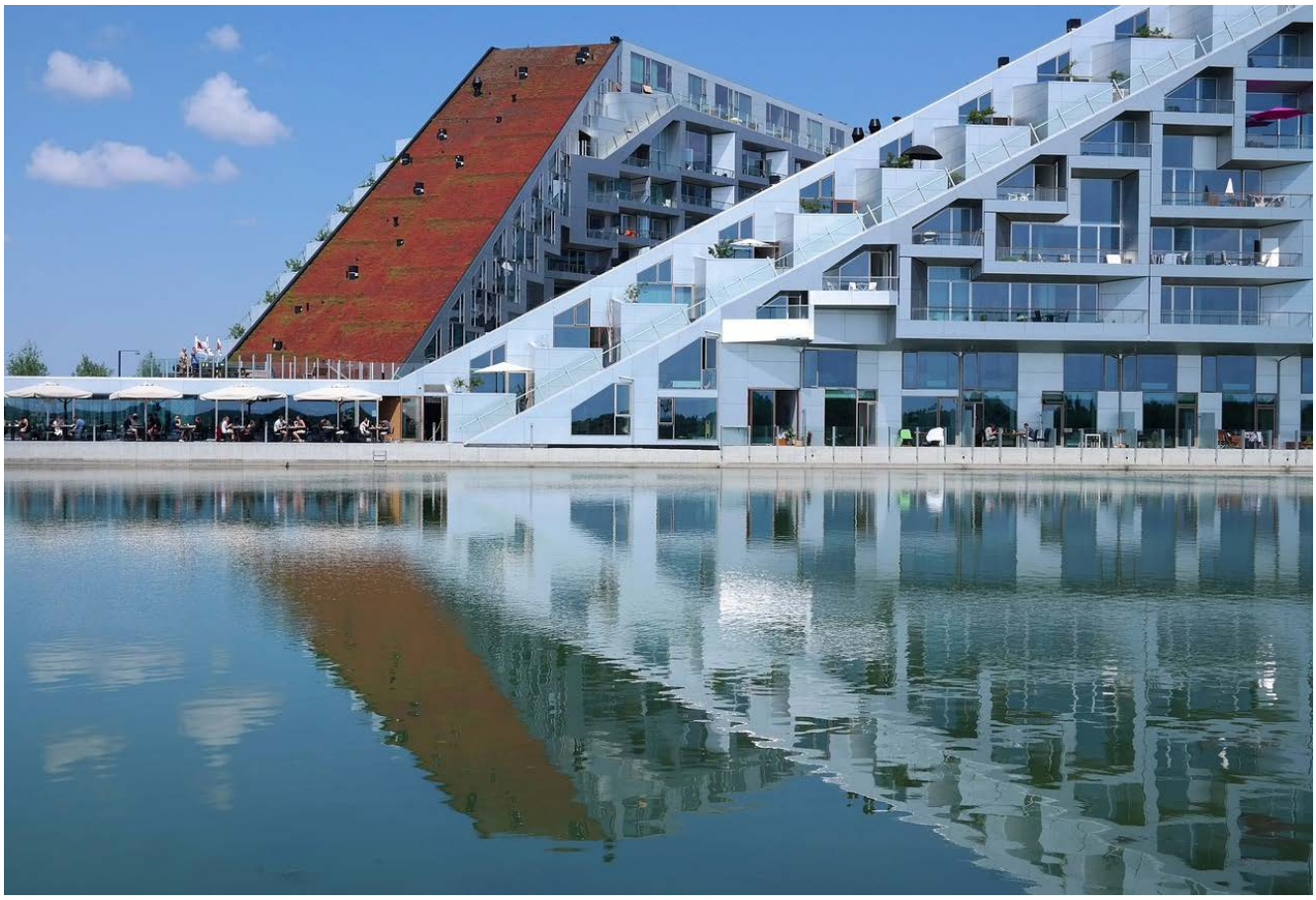
ENERGY POLICY

Denmark is determined to be independent of fossil fuels by 2050. The main task to achieve this goal is EE and an increase use of renewable energy. The country should consider more efficient energy consumption and be sure that it will help to make the transition to renewables as cost effective as possible. There are two main documents that demonstrate the energy policy and energy efficiency activities: *Our Future Energy*, November 2011 and *Energy*

[1] District systems distribute to end-users heat or cool water through pipelines produced in central locations. Hot or cold water is being circulated from the heat pumps to client and back. District systems offer major environmental benefits and allow to take advantage of market force driving price on natural resources. It is because it becomes possible to simply change fuel type (coal, oil or natural gas) at central place than changing every individual boiler (Steam & New, 2011).

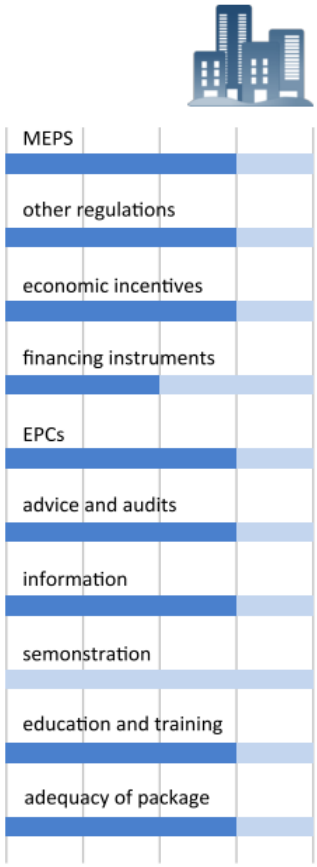
Agreement of 22 March 2012. On national level, the main responsible body of energy affairs is Ministry of Climate, Energy and Building. The Danish Energy Agency advises the ministry, and assist other authorities with the creation of the Danish energy legislation and development of the energy sector (ODYSSEE-MURE, 2015).

The Danish decision to increase energy efficiency means that the main task is to ensure stability by reaching long-term political agreements. It is also important to focus on households, industry and buildings. A variety of measures both economic incentives, standards and information should be taken into consideration. The official reports says that one of the core incentives in energy policy is Energy companies saving effort, which came into force in 2006. Another incentive to increase EEB is a buildings renovations strategy that came into force in 2014 with a target 35% reduction of energy consumption by 2050 (ODYSSEE-MURE, 2015).



NATIONAL ENERGY EFFICIENCY ACTION PLAN ASSESSMENT

Intelligent Energy Europe conducted a project portraying the progress made in implementation of energy efficiency policies following Energy Service Directive through screening National Energy Efficiency Action Plans (NEEAPs) and EU wide expert interviews (EEW, 2013). According to their analysis, Denmark set a high-quality plan with clear links between energy efficiency policies and strategic development targets to achieve fossil and fuel independency by 2050. The plan is well supported by sectorial policies. Regarding the building sector, a comprehensive policy package with most of the relevant elements was developed. The minimum energy performance standards are regularly revised. However, the problems were determined in the field of demonstration the projects, financing instruments and lack of cohesion in providing the relevant information (EEW, 2013).



Residential Sector - Buildings

Comprehensiveness of policy package	
Minimum Energy Performance Standards (MEPS)	• Mandatory MEPS for new buildings are in place and there is a roadmap towards energy-efficient buildings.
Other regulations	• Component requirements are included in the building regulations that ensure the use of high quality materials to support EE.
Economic incentives	• Economic incentives are in place (e.g. for heating system replacement)
Financing instruments	• Third-party financing is available, other financing instrumens are not mentioned.
Energy performance certificates (EPCs)	• Energy performance certificates are not mentioned in the NEEAPs but in the BPIE 2010.
Energy advice and audits	• The activities of the Energy Saving Trust include advice to end-users in businesses etc. but is not metioned explicitly in the NEEAP.
Information tools	• Information and motivation activities are commonly performed measures. • Tools, are provided by the Knowledge Centre on Energy Savings and others.
Demonstration projects	• No Demonstration projects are mentioned in the NEEAP.
Education and training for stakeholders	• Tools, information, education and training are provided by the Knowledge Centre on Energy Savings.
Adequacy of policy package	• The policy package is well-balanced with regulations, financing, and information/advice.

Figure 18. Progress of NEEAP in Denmark (EEW, 2013)

The positive assessment is defined from the outcome of interviews with 15 Danish experts: from their point of view, Denmark is the country where EE policies have progressed very well since first National Energy Efficiency Plan, all government levels and energy companies being involved in the overall process (EEW, 2013). Regarding the residential sector, positive

developments were specified, including building codes, building labelling and availability of instruments to support energy efficiency, including loans for building renovation.

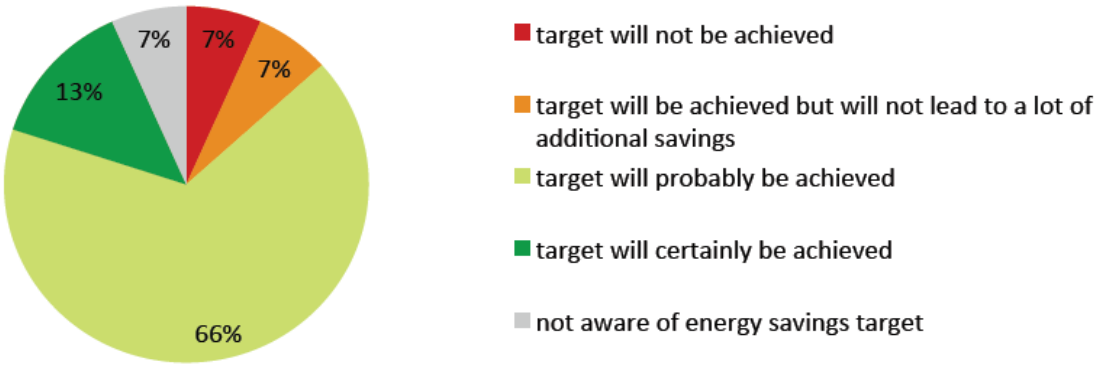


Figure 19. Denmark: Achievement of national energy savings target. (EEW, 2013)

IMPLEMENTATION EPBD

EPBD was implemented in Danish legislation in June 2005 by further development of strict requirements in building regulations by new labelling and inspection schemes. According to the DEA, it was followed up by regulations as:

- a new energy labelling scheme containing a number of changes and improvements,
- Special regulations for energy labelling of public buildings and large buildings,
- New supplements to the building regulations with increased energy demands on new buildings and the introduction of two new low-energy classes,
- A new inspection scheme for boilers and heating installations,
- A new inspection scheme for ventilation and air conditioning systems

(Energy Agency, 2015).

In the Danish case, the implementation of EPBD is the responsibility of the Danish Energy Authority and the Danish National Agency of Enterprise and Construction, which is responsible for regulation the production, supply and consumption of energy. It was established under the Ministry of Climate and Energy. It is the task of the Danish Energy Agency to advise the minister, to assist other authorities, to administer Danish energy legislation.

MUNICIPALITY SCALE

Fundamentally, the municipality of Copenhagen has a big influence on the urban development as it is their responsibility to give building permits. Besides having a regulatory role on land resources, they manage land ownership. The Copenhagen Climate Plan 2025 includes a significant focus on reducing emissions from the buildings, which are responsible for 75% of total CO2 emissions. To accomplish the plan in area of energy production as making district heating and cooling systems flexible and carbon neutral, and replacing all electricity energy supply to renewables, the initiatives include setting biomass in combined heat and power plants, installing more than 100 wind turbines onshore and offshore, implementing new heat generation units (The City of Copenhagen, 2012).

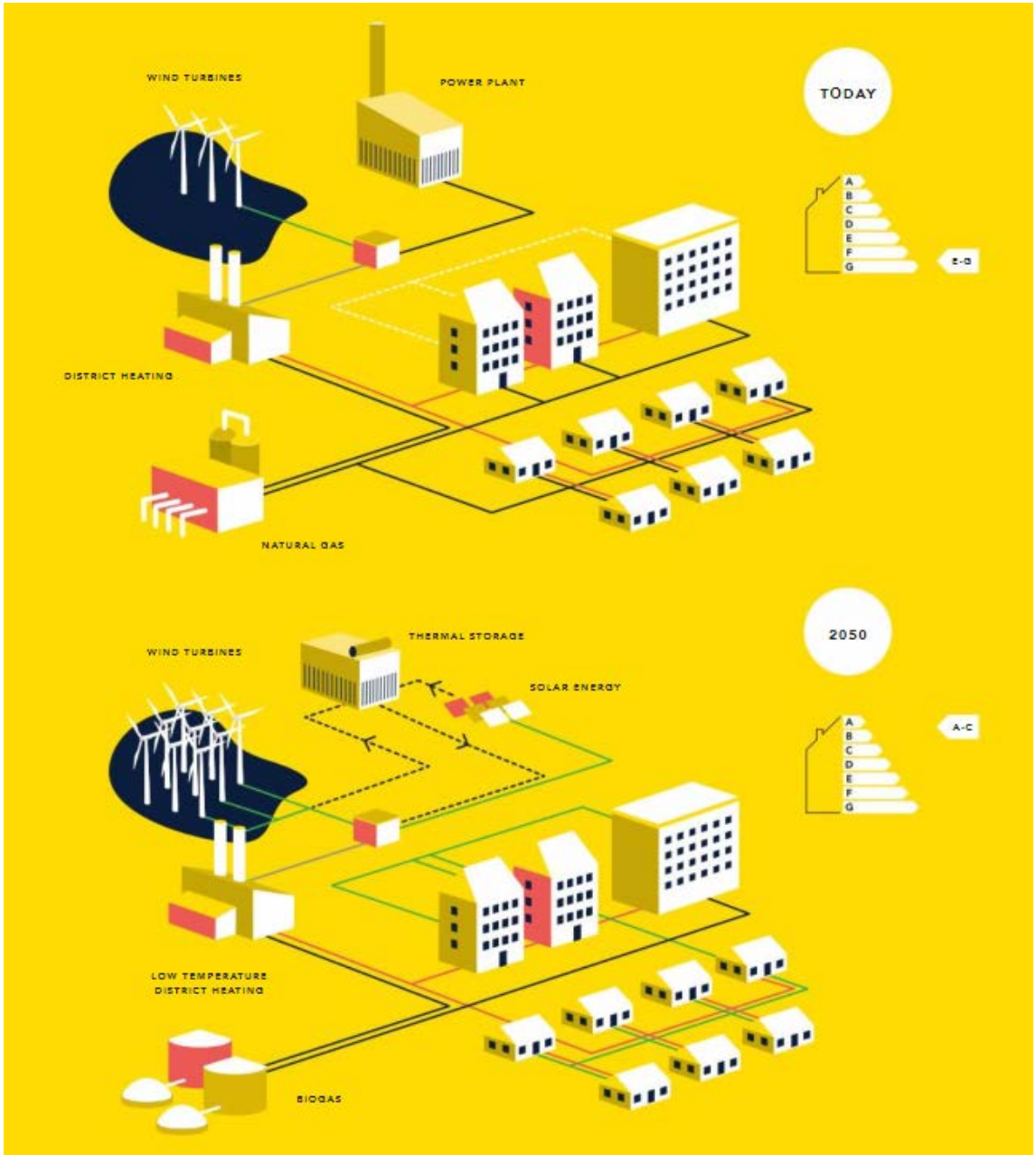


Figure 21. System synergies targets (Foresight, 2017).

Many buildings in Copenhagen were built before 1960, thus before implementation of EE regulations. According to the city authority, there is a lot could be done with EE improvements and there is a big potential in buildings renovation. Recent goals are to decrease energy consumption by 20% in commercial buildings, 40% in public buildings and 10% in households. There is a target to increase the level of retrofitting residential buildings by 0.5% per year (The City of Copenhagen, 2012). Public expenditure in actions towards energy consumption reduction of buildings until 2025 is about 170 m DKK. The required investment if newly built and renovations of old buildings until 2025 is about 180 bn DKK (The City of Copenhagen, 2012).

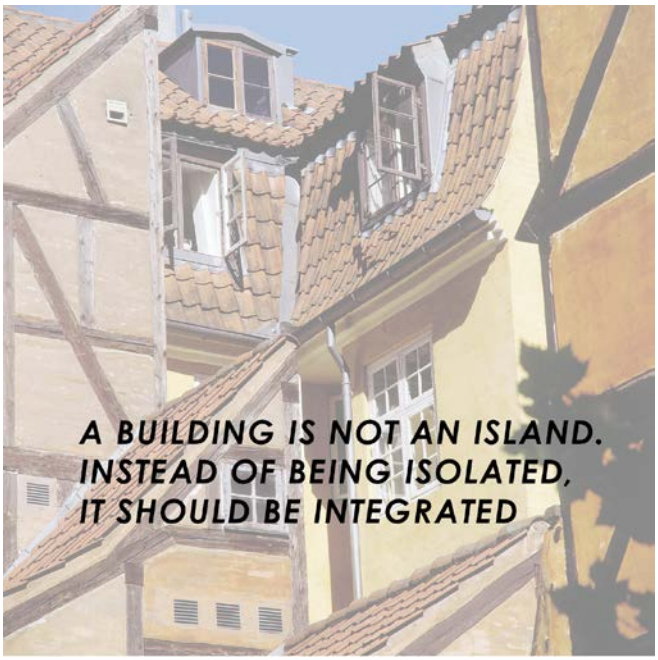
INSTITUTIONAL BARRIERS

The problems confronted due to structural characteristics of political, economic, energy system which make EE difficult are justified as institutional barriers (Bai, 2003). In Copenhagen, experts' interviews have determined two main barriers: one related to the extremely ambitious regulations on the national level, and to the economy incentives on energy from local politicians.

PARADOX EFFECTS OF REGULATIONS

'A building is not an island. If the building is not located individually in the mountains then it is probably part of a city. Instead of being isolated, it should be integrated: connected to the sewage, water, public transport, district heating and district cooling. In Denmark, a cost effective way is to produce and distribute electricity through the grid. The CO2 neutral building is not sustainable' (interviewee #10).

In different contexts, buildings are often considered as single entities, however nowadays there is a growing demand to look at the buildings as a component of a larger urban system, smart grid system or energy systems.



EPBD was criticized for being not flexible enough in setting the targets and requirements for frameworks among member states (interviewee # 7, #1, #11). The requirements should not contradict local efficient and cost effective solutions that benefit from the economy of scale. Denmark has a developed energy system, which offers sustainable energy solutions to the buildings that are attached to the city grids: '*Talking about sustainability it is important to consider not of a building but as a part of a larger system, not as a single entity where goal is to have zero energy. Building code requires us to do things*

not good from environmental perspective and economic perspective, because it treats it as an isolated island' (*interviewee* #1). New buildings, to fulfil the requirements of Directive and framework of NZB, have to establish individual sources of energy on the building. Technically it makes building independent and sustainable, but calculations have shown that for Copenhagen it is ineffective in terms of costs and makes the project unsustainable economically compared to the building attached to the district energy system: *The costs of installing solar panels is twice more expensive than to install to the field. In Denmark we tighten too much so you have to have your own local energy production, which, from the system view, doesn't make any sense, because you can get the same amount of energy and it supply to the building cheaper and it will still be green. So for example, it is more efficient to buy a share from a wind turbine for electricity, but it doesn't answer the new requirement because it is not on your roof* (*interviewee #1).*

Denmark is one of the first countries to implement building codes. It is a common opinion among responders that building codes gradually have been tightened up since 1978 and that regulations already are excessively ambitious to the point that it has started to cause problems. For example, there is an opinion that tight regulations regarding ventilation in new buildings led to decrease the indoor air quality. Therefore, to fulfil lack of air, people might start using mechanicals ventilations, which is very cost ineffective (interviewee # 7, #1). However, soon authorities will upgrade the building regulations again. Experts are afraid that it will bring more disadvantages: *'Because additional amount of newly saved energy is fairly limited comparing to additional costs to saving that last bit of energy If you compare the costs of saving energy to producing renewable energy'* (*interviewee* #1). Here is an example: *With first 5 mm of added insulation you save a lot of energy - nearly 50%, for the next 5mm you save only 7%. So adding more and more layers insulation material to the building you not saving a much bigger amount of energy. Today in insulation minimum requirement in DK building code it's about 40 cm of insulation in 2020. If we compare 35mm and 40mm there is only 3% additional saving. I don't know whether we have crossed the line whether it is not worth it anymore, but I know we are very close when we speak about insulation' (interviewee* #1)**.**

ILL- STRUCTURED POLICIES

Another common institutional barrier was identified as the fact that low energy tariffs discourage energy efficiency investments. The experts believe that in Denmark nowadays energy prices are excessively low (interviewee #2 ,#3,#7, #11). Consumers living in the house do not get tangible economic benefits by saving energy and are therefore not motivated to do so: *If we are addressing Copenhagen we have district heating based on waste, so it's rather cheap. If people cannot save much by reducing energy consumption, they may not have large incentives. Payback time is so long. So they not motivated to retrofit' (interviewee #5).* The energy price on energy in DK depends on is the owner – municipality, private company or public-private partnership and regulated by board. Experts see the barrier as a political barrier rooted in establishment of low energy price in general (Interviewee #2, #3, #5, #11). In the Copenhagen region, the situation seems to be even more complicated due to the variety of energy systems involved with different pricing structure (*interviewee* #11). The energy

regulations distinguish the energy price for regular consumer into two parts: variable part and extra part. The variable part reflects energy consumption, while consumers have to pay the fixed part to maintain the system. Evidentially, even if a person saves energy, the saving amount is very limited- not full credit (*interviewee* # 9, #11). An expert in the field of energy systems suggested: *to force politicians to make full variable cost, to make it more flexible and attractive to customer (interviewee #11).*

LACK OF POLITICAL WILL

Consequently, discussion has led to the direction of how to overcome the barrier and what can improve the situation: *Big assessment is needed to find out which solutions are more effective. There is still a lot could be done better from architectural and design perspective. Instead of making renovations and constant improvements, we need to focus on making things done right* (*interviewee* #1).

Experts noted that overall concerns about energy efficiency of the housing still very low. There is a very small probability that retrofitting will ever become obligatory: *(interviewee #7).*

Scholars distinguishe institutional failures between spatial, temporal and institutional scales (Bai, 2003; Delarue, Meeus, & Azevedo, 2013). Lack of political will is rooted in this notion. Problems related to the 'global' nature of climate changes issues are linked to the *spatial scale*. Local policy response is the top challenge of bringing global issues to the local level. The lack of clear understanding of ways to integrate tasks which tackle issues outside the administrative boundaries into the local agenda makes them leave it to the national or international government to handle and therefore could be called **'**Not my turf' (Delarue, Meeus, & Azevedo, 2013).

The long-term nature of climate change approach is linked to the *temporal scale.* Scholar calls those issues 'Not my term' issues and relates their roots to the limited time of local governing (Delarue, Meeus, & Azevedo, 2013). Creating new methodologies is time and investment consuming. On local scale the limited timeframe of electoral cycle commonly mismatches with environmental management timeframe. As mayor's governing term lasts between 3 and 5 years, the urgent challenges are prioritized in local agenda (Bai, 2007).

Another characteriatic of problems is linked to *institutional scale* and rooted in bureaucratic nature. 'Not my business' refers to the lack of expertise of local government (Delarue, Meeus, & Azevedo, 2013). Climate change, as intersectoral subject, corresponds wide diversity of issues. Middle argues that contemporary environmental issues do not clearly fit into the current structure government agencies and as a result involve a range of agencies.

Consequently, it raises inter-agency collision and decrease the performance (Middle, 2010). Consequently, as decision-making becomes more decentralized it generates more complex governmental arrangements in different scales. That leads to the next category of the problems relate to the complexity of actors involved.

MARKET BARRIERS

STAKEHOLDERS COMPLEXITY AND PROBLEM OF COMMUNICATION

'Finding the right incentives and finding the right ways to implement energy efficiency modes is not easy. It is not just one single solution: not just technical or organizational, not just one actor related, not one incentives, it is all kind of things that have to get together to make the change and it takes a long time' (interviewee #4).

Stakeholders complexity problem implies the diversity of stakeholders involved and lack of coordination between them (Delarue, Meeus, & Azevedo, 2013). The relevant literature suggests that recently obstacles in energy efficiency in building sector become more evident with growing complexity of decision making arrangements (Ryghaug, 2008; Levine et al, 2012). Fragmentation of the long lifecycle and involvement of a diversity of actors in different phases: property developers and financiers, architects, engineers, building managers, occupants and owners. Moreover, as there are multiple industries involved such as construction and energy industries, they set a multi-sectorial challenge. There are many public-private partnerships in buildings and energy sectors in Denmark. Since 2006, grid and energy distribution companies have been targeted for annual energy savings (Danish Energy Agency, 2015).

The problem with communication and coordination between actors was highlighted (interviewee #2, #3, #9). Seems that the system works quite well, although there is room for improvements. On some stages, actors do not think ahead regarding implementing or maintenance step and do not consider the best solutions (interviewee #3). There is a demand for a better network or a consultant, with a role of a mediocre actor who will control the process from the beginning to the end (interviewee #2, #3, #11).

SKILLS GAP/SKILL SHORTAGES

From the interviews it is clear that in general the lack of awareness among actors in Denmark is not a significant issue: *Most actors are aware. They should be aware. They might find it difficult, but they do understand that there should be market and ways to better market (interviewee #3).*

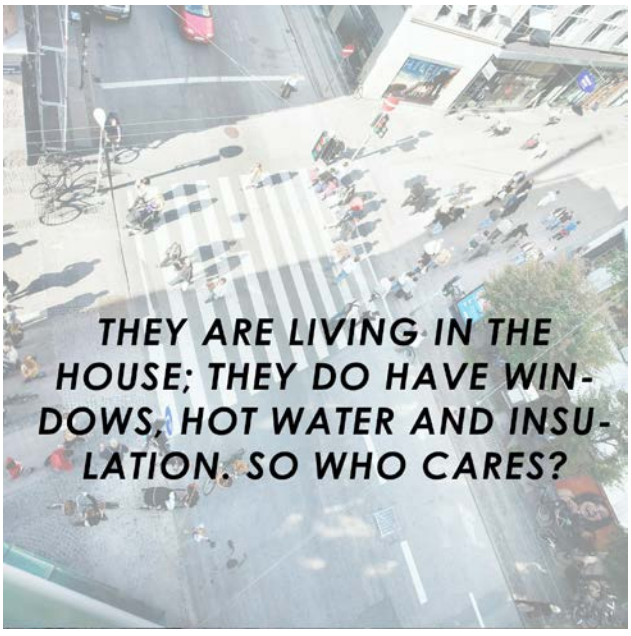
As mandatory regulations exist for a long while actors on market learn them and follow them (interviewee # 7, #1, #6, #3). However, there is an opinion that architects and engineers are being conservatives and not making enough effort in building commissioning. For instance, it was highlighted that '*they only calculate the costs but never maintenance' (interviewee #2)* and there is a demand to include in total costs parameter of maintenance, operation costs of the building as well as the clear lifecycle frame.

Additionally, some experts pointed out that the design stage need to be more environmental sustainability oriented (interviewee # 7, #1, #2). The conversation led to the issue of education and integrating environmental concerns in university programs. One of the experts, described that in Denmark environmental concerns goes up and down since crisis in 1980: *in the beginning of 80s and then 90s we spoke a lot about urban ecology, then no, last 5 years it has change again in direction to more sustainable (interviewee #5).*

Regarding shortage of skills, there is a common opinion that there is a lack of trained, specialised craftsmen, who could implement the energy efficiency improvements. (Interviewee #2, #6, #7, #3). The following statements elaborate on it: '*Craftsmen are all about 'just is about enough' - suggesting the cheaper option. But they need to twist it. For what is the best one' (interviewee #3),* or *:*'*craftsmen often do what they have to do and if customer asks for anything else, craftsmen often convince them not to do it. Therefore, craftsmen are a big barrier and do not let people do the right thing sometimes. Too many of them don't know enough about environmental concern and energy efficiency. Need more education' (interviewee #2).* As the retrofitting process is rather complicated, craftsmen have a role to *make 'to make your money value and spend time working in your house' (interviewee #7)* therefore it is important to have highly skilful and trustworthy craftsmen.

PROBLEM OF COMMUNICATION - MARKETING FAILURES

It seems that in general in Copenhagen the public is well-informed about energy efficiency regulations and solutions. Evidently, government has found a way to communicate polices: *Energy certificates with different levels exist for many years. Nevertheless, 5 years ago it came into law that you have to put the label into advertisement when you sell the house so you get the certification. That made a big change. Now when people buy a house they concerned about the energy mark (interviewee #2).*



However, a few responders highlighted that there is a concern that information regarding technologies and finance is fragmented and rambling, thus confuses the customer (interviewee #2, #3, #6). People are puzzled to find neutral, unbiased information: *they have all bit of pieces of information around them, but it's not good together in a package* (*interviewee* #3).

After all, optional incentive to invest in housing energy efficiency is still low (interviewee #1,#2, #3, #6, #7). Although, it seems that good marketing has a big potential to influence the public, it is very hard to draw attention and engage the public in energy-efficient housing: *Human factor. How are you going to do to make the population, except the 5% who are engineers, to be interested in this? It is just disturbing them. They are living in the house; they do have*

windows, hot water and insulation. So who cares? That is the main issue (interviewee #3). Nevertheless, experts admit that in Denmark marketing was inefficient for a long while due to the wrong strategy: *For 30 years we have tried to convince people to save money by saving energy, but now we are trying to sell the better houses instead. And it's really what is trigging people. They have some dreams for a house, so we have to start there (interviewee #2).*

Experts argue that for a regular homeowner who is not interested in EE, it is overwhelming to be forced to think about it. Therefore, the information to homeowners should be conducted in a simple and easy way, even though personal contact. Moreover, the source of information must be trustworthy: *Ideally, the initiatives should come from the actors, whom citizens trust. For example, the public institutions, or neighbors who had experienced it already. Especially if you do a deep renovation, and your house is being remodeled, it affects your everyday life, you need skillful trustworthy workers. Sociology is very important when it comes in triggering people. Subsidies and guarantees might play a good role here (interviewee #11).*

The municipality and energy companies need to have better strategies and invest more into better marketing and communication. For regular consumers easy access and personal contact could be crucial.

Many experts were referring to a project called BedreBolig (Better Homes) as an example of promoting energy efficiency tool (*interviewee* #2, #3, #8). The initiative came as part of the strategy for energy retrofitting of all Danish buildings from 2014. *It is a kind of a "green deal" based on the one-stop-shop idea. The initiative is aimed at homeowners and provides them with consultation regarding retrofitting of their homes, including identification of the energy saving potential as well as project management of the retrofitting process (interviewee #8).*

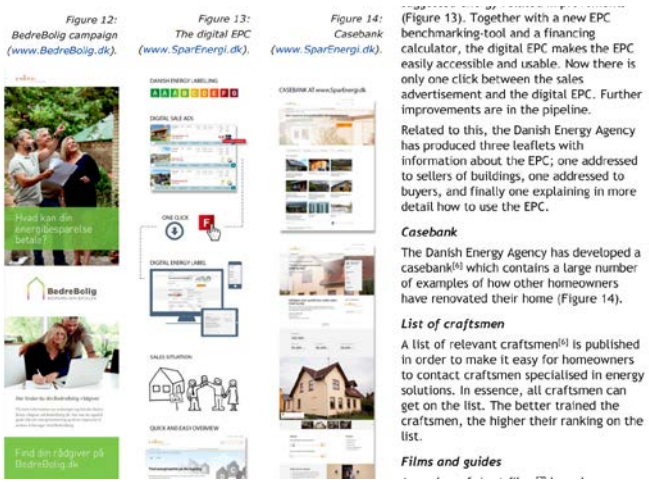


Figure 22. BedreBolig webportal (Oñate, 2017).

However there is a critique regarding this project: *For a customer campaign it provides too much information, it helps but does not solve the problem of energy efficiency being unattractive (interviewee #7).*

One of the interviewers has given an example of a different project in Hoeje–Taastrup Municipality in Greater Copenhagen that aims to assist homeowners in increasing energy

efficiency in the houses. The idea came from the fact that homeowners find its difficult to get information of energy efficiency possibilities for each case: *they usually complain they do not know: the options and the prices, they have all bit of pieces of information around them, but its not good together in a package (interviewee #3).* The municipality came with the proposal of collecting all necessary data on a platform, that comes from municipality database and includes information of what kind of heat supply is available on each house, energy consumption, info about the building, what's the value of the house, who registered there and data about these people like age, registration, approximate income of each family. Taking into consideration all these aspects, the municipality plans to calculate and find out the best possibilities for energy efficiency improvement. They want to deliver this information to each house. The interviewee believes that the biggest advantage of this project is the municipal access to data, which allows to target each family with the best personal possibilities rather the usual showcase campaign. Although only the municipality and energy company will have access to database, there is a problem of dealing with personal data. There are new regulations coming into force as European Directive on personal data that creates a barrier.

LACK OF UNDERSTANDING FINANCIAL SCHEMES

In regards to the Danish welfare systems, no lack of consumers' money was mentioned. Prices are low and main population can afford it. Experts referred to specificity of very convenient Danish financial schemes, bank loans, and municipality subsidies.

The most commonly cited financial barriers were issues around payback expectations from energy improvements investment. The unwillingness to invest roots in lack of understanding the value of investment and payback.

I see a big barrier in the economy side. Most of the people have an access to the finance to invest. The problem is, that many of the people are not aware. However, it is a big investment and big decision, and unfortunately for most of the people it doesn't appear as an attractive step. I would call this barrier is physiological economic barrier, describing not the lack of money, but preconception of losing a big amount. For them EE does not appear as necessity and they not ready to sacrifice being locked at the place/house for few years waiting for the payback time (interviewee #5). Inhabitants are not aware about the economic benefits. It is not blowing away money there is payback (interviewee #6). There are campaigns you can get a subsidy, but its only covers a small part of investment in the building envelope. If you change your window for example, the subsidy from energy company will cover 2-3 per cent, very low subsidy. If you change to new boiler, probably 15 percent. Simply because the gain of efficiency is greater. So technical equipment is higher (interviewee #1). Finance? There is no pay back. Forget it. Although it is increases the value of your house. Danish system for retrofitting offers very easy loans, so lack of money is not excuse (interviewee #3).

One of the experts pointed another concern: *It is easy to loan money today. More than half of population can get a loan. Another problem is people have to move out for a while to retrofit? Where? (interviewee #2).*

A number of Danish enterprises also offer more specific energy services in the form of various kinds of ESCO cooperation[2]. Danish municipalities in particular have made use of various ESCO models (Danish Energy Agency, 2014). Experts' opinion on the efficiency of ESCO companies in Denmark*: Energy service company concept- they deliver energy savings, they discuss what kind of solutions better, and gives guarantee for saving money, after building was retrofitted they stay and operates for couple years. As they are popular all over Europe, in Denmark it was a big growth also. They carry a lot public buildings. They can plan investments safer. They will pay the difference, which makes it attractive for municipalities. However, there is a need in increasing level of understanding (interviewee # 4).*

IST RISK AND UNCERTAINTY OF NEW TECHNOLOGIES

There is a barrier related to uncertainty of new technologies and the impact of it in a form of a risk of implementation. Although industry has the capacity for newer solutions, costs and risks behind, it blocks the process (interviewee #9). In Denmark besides the current 2015 building code, there are already available updates for 2017 and 2020 and new building could follow the requirements already (interviewee #1, #7, #9). However, only a small share of new buildings comply the highest regulations.

On the other hand, IST (Intelligent Smart Technologies) solutions are on the market and have a potential for efficiency improvements in existing buildings. However, nowadays they are not integrated well due to their complexity, price and unattractiveness for regular consumers. Up to now they constitute isolated technological solutions reflecting the same system, and therefore need to be simplified and integrated: *Why on earth I have 4 different applications to control one complicated system? Today they are far too complicated and far too expensive (interviewee # 3).*

END-USER BARRIERS

All experts reported barriers that are related to decision making on end use. Most of the responders specify problems with existing buildings.

LACK OF PRIORITIZING ENERGY EFFICIENT VALUE WHEN PURCHASING A PROPERTY

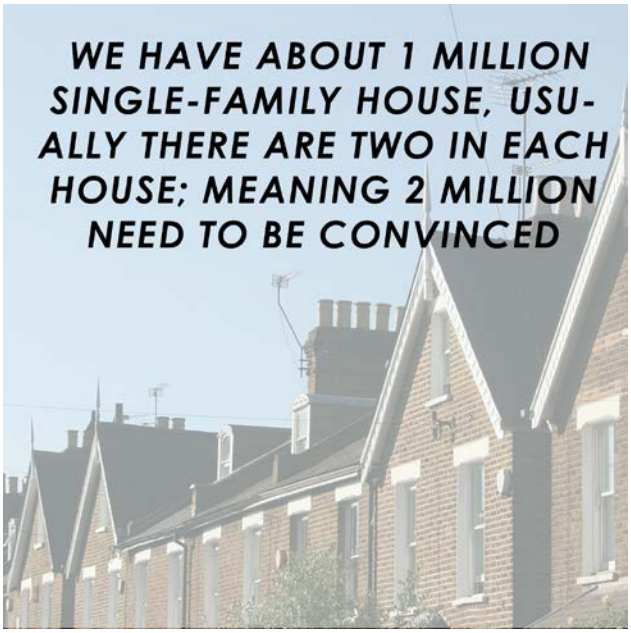
There is an opinion that energy efficiency is not a prior value when buying a property. Choosing a house is known for being an emotional decision, based on client's external perception and internal feelings about the house. Another influential factor is the financial factor – to accomplish projected costs. Although the public in Copenhagen is aware of building

[2] ESCO (The Energy Service Companies) is a commercial or non-profit organization that finance or arrange financing for the operation and their remuneration is directly tied to the energy savings achieved. ESCOs accept some degree of risk for the achievement of improved energy efficiency in a user's facility and have their payment for the services delivered based on the achievement of those energy efficiency improvements (Retrieved from: https://ec.europa.eu/jrc/en/energy-efficiency/eed-support/energy-service-companies)

codes, it will never become their priority in making a decision when purchasing a property (interviewee #7, #9).

BARRIERS IN THE DECISION MAKING PROCESS IN EXISTING BUILDINGS

Nearly all experts reported barriers related to multiple owners or occupiers of the residential buildings. Lack of personal responsibility and coordination on building level generates difficulties on agree on energy improvements. To understand better the process on the decision–making process in existing residential buildings below the types of ownership in houses in Denmark are listed:



1. Privately rented apartments in multi-family houses. One owner who decides. This type of ownership confronts broken-agency problem. Owner has to make the energy-efficient investment, but it results in a lower energy bill for the renter. In the end, tenant gets the benefit not the owner. Danish regulations protect the tenant and do not allow raising rent price easily.

2. Cooperatives. Co-owned by individuals who can buy a share of the building. On assembly, they make decisions regarding changes and investments. Usually owners are tenants at the same time. *This type of ownership lacks for incentives and therefore problematic for retrofitting (interviewee* #4).

3. Social housing. Social housing is independent neither private nor public organization. Strict regulations on democracy and ruling the building. The model is unique. Balanced rent with investments, tenants influence a decision as well. They select a board by voting at general assembly once a year. Interviews showed that this type of ownership does not have any significant financial or institutional problems in building renovations: '*Social houses, they do very successful projects. Seems they follow already 2020 standards'* (*interviewee* # 2).

4. Single-family housing. Experts argue that single-family houses confront the biggest problem (interviewee #5,#2). One of the experts had a strong argument that describes the challenge confronted when considering this type of ownership: *Private houses are the biggest challenge for Denmark. Because we set a goal to become carbon neutral by 2050 and we can produce a lot in renewables, but energy efficiency in private houses has a big share. Energy consumption in single family is huge. In Denmark, we have about 1 million single-family house, usually there are two decision makers in each house; meaning 2 million need to be convinced (interviewee #2).*

BROKEN-AGENCY EFFECT

As it was mentioned above, the privately owned dwellings are confronted with the broken-agency problem: *for some owners who rents out the space for offices or tenants there is no payback at all (interviewee #6).* This barrier is known under various names mostly common as the 'split incentives barrier' or the 'landlord/ tenant barrier', the 'investor/user barrier' and the 'principal/agent barrier' (Economidou et al., 2011). The research of Buildings Performance Institute Europe (BPIE) on energy performance of the building among EU member States showed that this is the most complex and long-standing barrier relating to existing buildings, due to the high level of rental accommodation in the residential sector (Economidou et al., 2011). The barriers were identified as one of the most significant among interviewed experts (interviewee #1, #2, #3, #4, #5, #6, #7, #9). This barrier could be considered as financial due to the financial implications from one hand, and as institutional from another hand (Economidou et al., 2011).

The problems are rooted in the circumstance when the owner individual or organisation does not use the property himself. For the owner, the investment is supposed to bring the benefit, however, if he does not consume and save energy he invested in, then the tenant will get the benefit from saving in his energy bill. However, due to the legislative restrictions, the landlord cannot raise the rental price. Consequently, investment in energy efficiency does not seem attractive to the property owner. A comprehensive analysis on split incentives undertaken by the International Energy Agency determined that this barrier reports for about 30% of sectorial energy use and that no single policy instrument can address it: *Neither regulatory mechanisms, (e.g. minimum energy performance standards, or regulated contract design), nor information-based instruments (i.e. awareness campaigns) alone will resolve them. Instead, governments should help design well-targeted policy packages to address PA problems in their specific national contexts, and within the particular constraints of a given sector. These packages should include measures to: a) address contract design to ensure end-users face energy prices, b) regulate the level of energy efficiency in appliances and buildings, c) improve access to information about energy efficiency performance* (Economidou et al., 2011: 60).

LACK OF MOTIVATION IN BUILDING RENOVATION

In Copenhagen, all experts highlighted retrofitting as the main challenge in EE residential buildings sector. They argue that there are less problems with new buildings due to the mandatory requirements coming from building code. Moreover, the share of new constructions is rather small: '*The biggest challenge is retrofitting. New building activities are relatively low – only 2% each year new building supply. Never ending story. Research in retrofitting area much less than new buildings' (interviewee #4).* Regarding the existing buildings, municipality had already renovated publics buildings, however private property outside their capability *: If it is our own building then we can do them efficient, but with private we cannot ask them for more than building code asks (interviewee #6).*

Interviews showed that people are aware - they have basic knowledge about EE. However, solution how to influence and motivate public to retrofit their dwellings is missing: *'Retrofitting*

is the biggest issue. To make them decide to retrofit, take the time and invest the money. Convince them' (interviewee #2).

One of the opinion noticed that people are not concerned about their energy consumption: '*Many people don't know and don't care. People here do not know how much they pay for the heating. So when you do not know what you pay then why would you care about saving here? They take energy for granted' (interviewee #1).* Moreover, seems that they are sceptical that renovation is troublesome and time consuming: '*One thing is a knowledge, another thing is if you want to change the heat pump you have to destroy your garden, if you want to change building envelope, you need someone to run around for a month. So people don't want to be bothered' (interviewee #1).*

Interestingly, it was noted by expert from Copenhagen Municipality that it seems that homeowners do not understand influence of EE improvements in increasing the overall value of the buildings: *'those here they do not understand that the benefits in increasing value of the houses. The do retrofit but not because of energy' (interviewee #6).* The answer seems to have roots in Scandinavian mentality – people staying most of the time indoors and therefore developed a strong necessity of taking care of home and ready to invest in pleasant indoor climate*: Here in North we more focus on indoor house. In a new investigation it turned out that people do retrofitting not because they want to save money, but because they want to have more comfortable healthier house with better indoor climate. I think it is should be big marketing motivation (interviewee #1).*

Generally, all interviews determined the human factor as the hardest to overcome barrier: '*The main issue is the human factor. What is a good thing to decide to invest? Human barriers need to be overcome. To help them to make right decisions. How to integrate small niches, synchronize it' (interviewee #3).*

REBOUND EFFECT OR USERS UNEXPECTED BEHAVIOUR

To understand better the idea of end users-behaviour one can have a look at the energy consumption trends.

If we follow the energy consumption in household sector in last decade, there is a general decreasing trend. However, when assessing energy consumption, a strong influence of weather variables should be taken into account. According to the Danish energy agency, the year 2000 was significantly warmer than the year 2010 in Denmark (Danish Energy Agency, 2015).

Graphs below show the trends in recent decade in energy and electricity consumption.

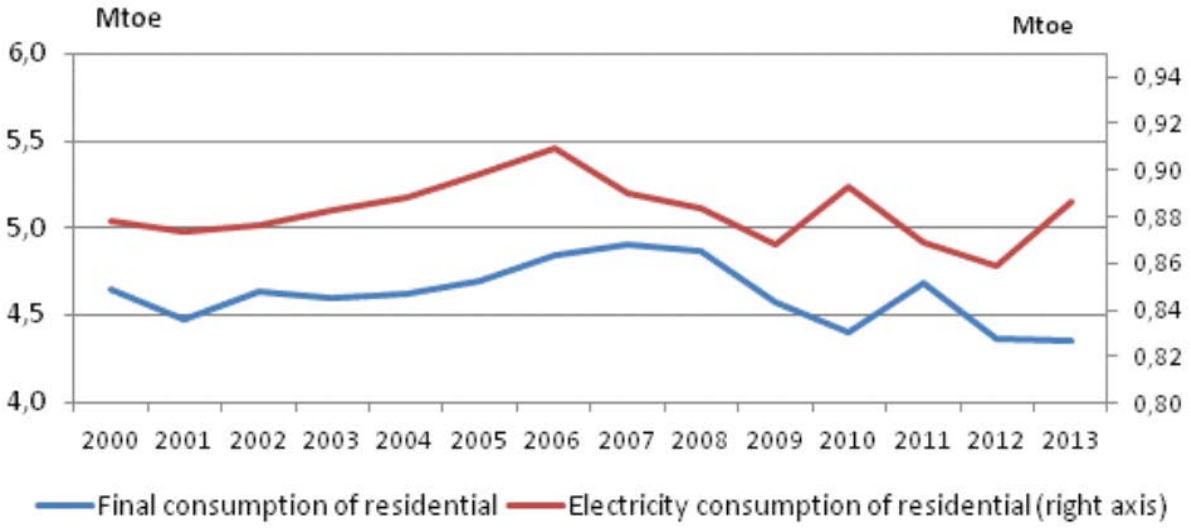


Figure 23. Final energy consumption and electricity consumption by the residential sector in Denmark. Climatic correlation. 2000-2013. (Danish Energy Agency, 2015)

The final energy consumption of households decreased by 6.2% in the period 2000 to 2013. This is a decrease of 0.5%/year in average. The final energy consumption increased by 5.7% in the period 2000 to 2007 corresponding to 0.8%/year in average and decreased by 11.2% in the period 2007 to 2013 which is an average of 2%/year. The electricity consumption of households has been on the same level in the years from 2000 to 2013. The consumption increased in the years 2000 to 2006 by 3.5% and decreased in the years 2006 to 2013 by 2.5%.(Danish Energy Agency, 2015)

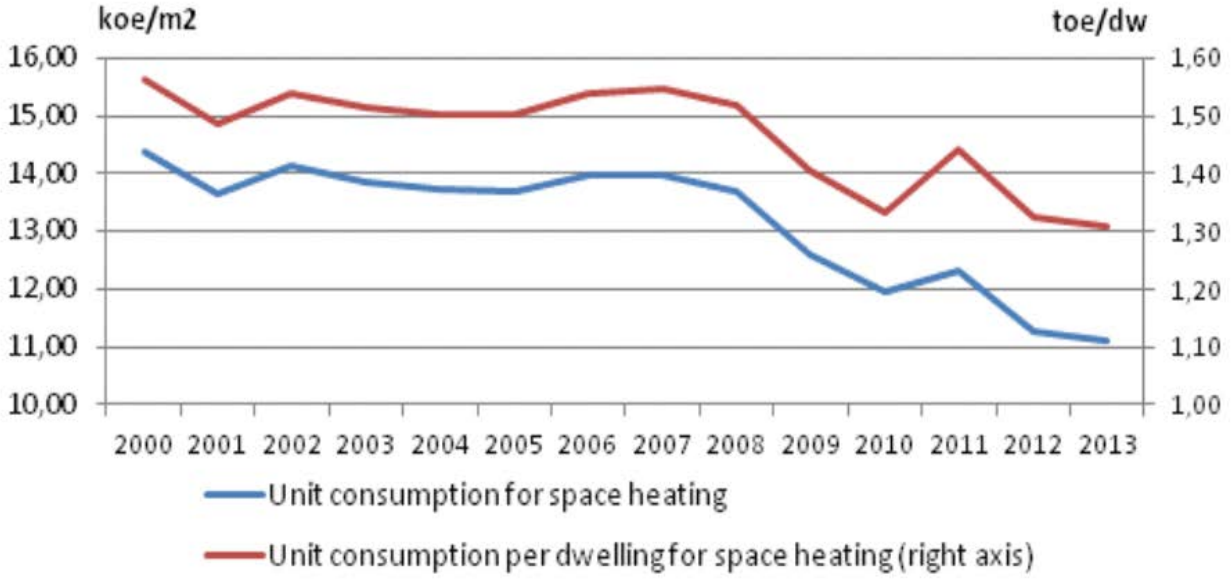


Figure 24.Heating: unit consumption per dwelling and m2 in residential sector. Climatic correlation.2000-2013. (Danish Energy Agency, 2015)

The energy consumption for space heating per m2 has shown a decrease during the period 2000 to 2013. The energy consumption has been at the same level from 2000 to 2008 whereas from 2008 to 2013 a decrease of 19% is observed. The same pattern as for space heating per m2 is seen for energy consumption per dwelling (Danish Energy Agency, 2015).

Not surprisingly, it revelled that human behaviour and mentality play an important role when it comes to building maintenance (interviewee #1, #2, #3, #4, #5, #6, #7). There are different ways to acquire new habits, for example leading to lower energy consumption: *'example of a strategy to argue for lower consumption is shorter bath or lower indoor temperature. Change the level decrease 1 degree in heating system you will save 7% of energy consumption' (*interviewee *#5).*

Furthermore, to construct EE building equipped with efficient technologies is only one side of the coin. The control of the building maintenance is another challenge, which is very hard to solve:

'*It seems to me they are able to build the houses. The problem is what you expect from using the energy and building after it was build or retrofit. Quite often, people behave different from what we expect. In reality, people change the behaviour once they moved back to a retrofitted building. Maybe they have a higher comfort level' (*interviewee *#3);*

*'We see some new results of calculated energy consumption and it gets worse. Even people who buy an efficient house, they forget their behaviour. They think that once they bought a house that doesn't need energy thus why would they be concerned about it (*interviewee *#2).*

An expert from Copenhagen municipality noted that in administration they often receive unexpected data on energy consumption*: We have regulations how to make new buildings and improve old ones properly. However, calculations show that in new buildings there is often more energy that is being used than was expected. At the same time, old buildings, with outdated systems use very small amounts of energy (*interviewee *#6).*

A more specific example was given to explain mentality change (interviewee #4). In professional fields the Rebound effect is the name of a phenomenon when consumers invest profit money from energy savings environmentally unsustainably - in a way using more energy, contradicting the whole idea of energy saving: '*Rebound- means how you spend saved money from energy? New car of flight? Hard to address this issue (*interviewee #4). For instance, there is a common trend in Denmark to obtain more living space. For consumers it seems attractive and easy to afford, especially when operating costs less: *'Whole big discussion on goes beyond efficiency. Rebound effect. We are very good at making things efficient. Nevertheless, we at the same time get much more housing space per inhabitant; we live on more square meters. As a homeowner, I used 50 kW per sq.m ten years ago. Today I will have much less consumption but I will have twice much space because our expectations and demand for space is growing. That means as energy consumer I will have the same level of energy consumption as 10 years ago. That is a big problem. Who has responsibility to control space?' (*interviewee #4). Apparently, it is hard to tackle these issues: '*Issue we do not do much about because it is hard to show the result, you cannot calculate them in simple*

*way. Especially politicians, they do not allocate money this way' (*interviewee #2*).* It was discussed that there are tools to initiate and influence people for example though education or marketing. Some municipalities in Denmark succeeded influencing through financial incentives as tax reduction or subsidies (interviewee #2). It was noted that overall, *new government had given up changing people behaviour - their plan is to change energy supply system instead of targeting people* (interviewee #2)*.*


METROPOLIS

4.1.4 MADRID

CITY PROFILE

The autonomous community of Madrid has a population of 6.4 million inhabitants while the municipality of Madrid has over 3,2 million inhabitants (Eurostat,2015). Being Spain's capital city, Madrid performs as the main financial, administrative and transport center and accounts for around 10% of national GDP. Madrid performs at the lower level among western European cities but ranks above eastern European cities in terms of average annual income (Economist Intelligence Unit, 2009). According to the European Green City Index ranking, this city is defined by good performances in sectors of carbon dioxide (CO2) emissions and water. It is important to underline that sustainable development is newer to Madrid than other many of its western European neighbors. However, the city has set ambitious targets (Economist Intelligence Unit, 2009). In the aftermath of the economic crisis of 2008, the rising debt level of the state made austerity an important consideration of Spanish policymaking (European Environment Agency, 2015:4). Since then, the result of efficient policies combined with effect of economic recession push energy consumption to meet 2020 targets.

Figure 25. Madrid performance by European Green City Index research (Economist Intelligence Unit, 2009).

Madrid ranks 12th for energy consumption in the European Green City Index, with energy consumed per head marginally lower than other European capitals average (Economist Intelligence Unit, 2009). The consumption is mainly based on electric power, oil-based fuels and natural gas with share of renewable energy less than 3% of total energy consumption. Recently, solar power use has increased significantly and the use of coal has fallen

substantially. Madrid's Climate Change Prevention Plan set a target of a reduction up to 20% in use of fossil fuel by 2020 compared with the 2004 level (Economist Intelligence Unit, 2009).

Madrid ranks 17th with regards to the energy-efficient performance of the building stock. Its average annual energy consumption per square meter in residential buildings is lower than the index average.

It should be mentioned that nowadays minimum energy performance standards for new and modern buildings are being used. Since 2013, owners of buildings have to present an Energy Efficiency Certificate (EPC) to buyers or renters of properties. This certificate evaluates the efficiency level of the building in terms of energy consumption and carbon dioxide emissions. The financial support is given through grants which is about 22% and 35% of investment costs under the Renove Plan (European Environment Agency, 2015).

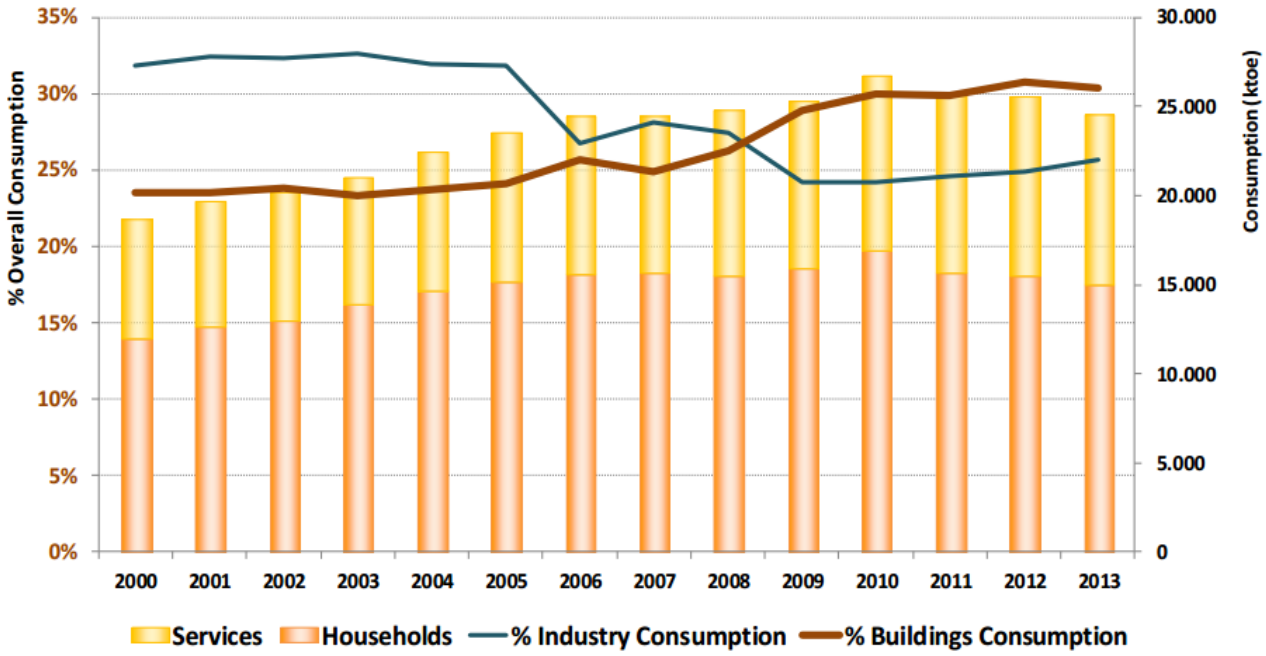


Figure 26. Share of buildings in final energy consumption in Spain, 2000-2013. (IDAE, 2015)

Taking into account the building sector in Spain one can see that it is obtaining more weight in the global energy demand, while there is backward movement in the industry sector. Energy consumption in buildings has decreased as in some European countries. In 2013, energy consumption in buildings amounted for 30.4% of total final energy consumption, and 64.6% of electricity consumption.

According to the information received from the Ministry of Development, the total surface of buildings exceeds 5,000 million m2, and about 60% corresponds to buildings in the residential sector. In the last years there has been a sharp decrease in the residential sector buildings (IDAE, 2015). According to the Ministry of Industry and Energy during 2014 out of its 239 newly-constructed buildings in the Autonomous Community of Madrid, 116 achieved energy certification C, 43 have D and 15 are rated as E, 54 rated with B and with 11 obtaining certification A. However, out of the 197,332 existing classified buildings in the Autonomous

Community of Madrid, 32,168 are rated G; 22,220 have F; and 102,468 are rated E and only 9,200 exceed the D rating. Although EPBD required the implementation of nearly-zero energy consumption buildings by 2020, new buildings are still being constructed that do not achieve higher than a D or E energy certification (Pereda, 2015).

The given figures confirm the low energy efficiency of existing buildings without taking into account any energy efficiency criteria, because of a lack of standardization in this regard and also due to economy in the quality of the construction. There are more than 1.5 million dwellings in Madrid of which 70% were constructed before 1980, as such, prior to any standard regarding energy efficiency. Another important figure refers to the so-called energy poverty (PV). According to the ACA, Environmental Sciences Association, one out of every ten homes in Spain is in a situation of fuel poverty, it is more compared to the situation before the crisis. For example, cuts in gas supply due to non-payment amounted to 75,162 in 2013 all of which correspond to small customers, i.e. Spanish homes, up 86% compared to 2012, according to the 2013 report drawn up by the CNMC, National Markets and Competition Commission (European Environment Agency, 2015).

ENERGY EFFICIENCY

In Spain, the support for renewable sources of energy was suspended in 2012 in order to solve the problems connected with the persistent tariff deficit of the electricity system. The costs of the electricity system are not balanced by revenues from retail prices, because these are regulated, so the expansion of renewable energy sources decreased. Besides, these measures have worsened the profitability of existing projects and diminished investor confidence. One can assume that successful investment in renewable energies could revive the renewable energy industry, create profits and employment in this field and country's transition to a green economy. In 2012, around 80.000 direct jobs and nearly 9 billion EUR of turnover were generated by the renewable energy sector alone, without even considering the supplying industries (European Environment Agency, 2015).

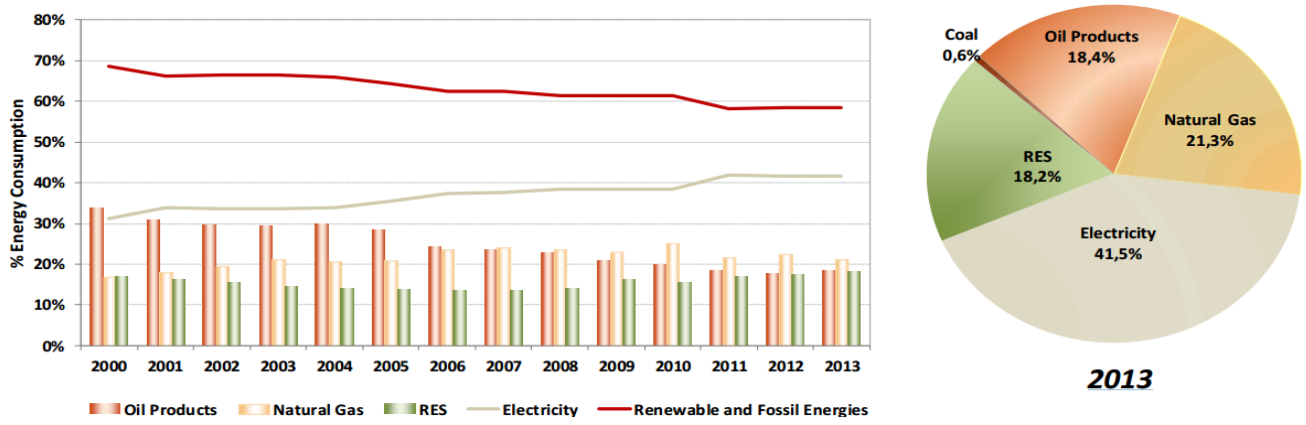


Figure 27. Structure of energy consumption of households by energy sources in Spain, 2000-2013 (IDAE, 2015).

In 2013, demand for energy consumption in the residential sector decreased and amounted to 18.6% of the total consumption. Taking into account the kind of energy needed for the residential sector it should be noted that both fossil fuels and renewable origin were used (58%) and electricity met 42% of the demand. So the prevalence of fuels accounts for the importance of thermal uses in this sector, among which the heating consumption stands out. (IDAE, 2015). Between 2007 and 2014 the electricity bill for the average home has increased by 76% and the gas bill by some 35%, while income has dropped as a result of the crisis by 8.5% over the same period, according to the INE, National Statistics Institute (Pereda, 2015).

ENVIRONMENTAL GOVERNANCE

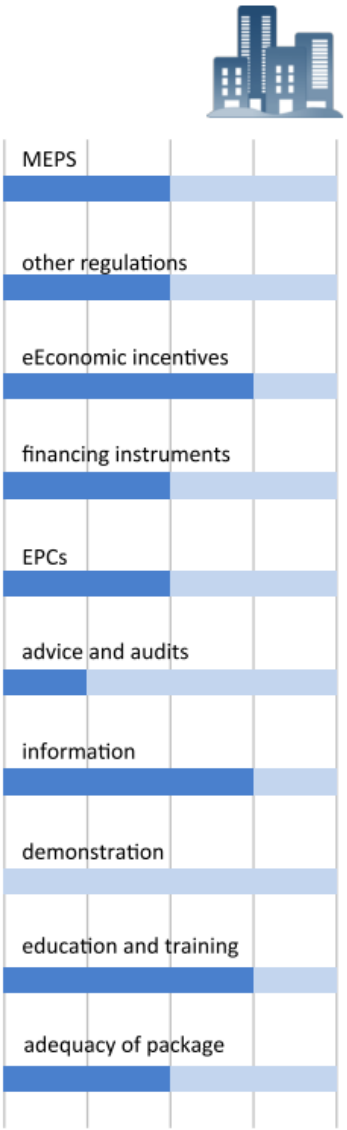
At the national level, the Ministry of Industry and Energy and Tourism (MINETUR) leads energy policy formulation, which is responsible for drafting and implementing government policy on EE. The Institute for Diversification and Saving of Energy (IDAE) is a public body belonging to the MINETUR through the Secretariat of State for Energy. IDAE is the main body in implementing energy efficiency policies and it manages energy efficiency programs and projects to help Spain meet its 2020 energy efficiency target and develops measures in coordination between the autonomous communities. IDAE also leads the development of the National Energy Efficiency Action Plan. The National Action Plan for Energy Efficiency 2014-2020 has been approved in compliance to the requirements by the EU Energy Efficiency

Directive. The NEEAP is a compilation of what has been done and what is to be done at the level of use of renewable energy, energy saving and reduction of CO2 emissions. The Plan presents targets and measures that include investment incentives, promotion, training, dissemination and legislative actions (IDAE, 2012). NEEAP is a part of the encompassing Spanish Strategy for Climate Change and Clean Energy outlining the policy framework and targets until 2020. Another influential supportive document is Renewable Energy Action Plan 2011–2020, which aims to promote public investment mostly allocated to electricity-generating installations (mostly wind and hydropower) and facilities for thermal use (European Environment Agency, 2015)**.**

In terms of horizontal EE measures regarding the building sector, JESSICA - FIDAE Fund is one of the main projects aimed at financing urban projects of energy efficiency and the use of renewable energy. Another instrument is National Fund for Energy Efficiency (NFEE) aimed at financing the efficiency measures of a varied mechanisms as economic, technical assistance, training, etc., that contribute to increasing energy efficiency in various sectors (IDAE, 2015).

SPANISH NATIONAL ENERGY PLAN ASSESSMENT

Intelligent Energy Europe conducted a project portraying the progress made in implementation of energy efficiency policies by the Energy Service Directive through screening NEEAPs and extensive EU wide expert interviews. Based on their approach, the Spanish energy efficiency policy is considered average. On one hand, assessment admits the NEEAP potential for crucial improving energy efficiency in Spain until 2020, but on another hand it highlights lacks a long-term vision until 2050. Another highlighted positive aspect was very strong existing energy agencies at government level and monitoring, reporting and verification schemes. The analyses of NEEAP accepts the application of minimum energy performance standards and economic incentives, but criticizes the lack of sanctions for non-compliance, specifically for a floor area less than 1000 m2 (European Environment Agency, 2013).



Residential Sector - Buildings

Comprehensiveness of policy package	
Minimum Energy Performance Standards (MEPS)	• MEPS exist since the late 1970s. They are adjusted and implemented in new laws after probation. • Not always clear how compliance is ensured.
Other regulations	• Regulations on new electronical devices. • Building inspections are planned to be part of future law.
Economic incentives	• Economic incentives available for new and old buildings.
Financing instruments	• Financing aid available for different targets. Incentives through capital grants or bonus interest rates (loans).
Energy performance certificates (EPCs)	• EPCs are established but sanctions or benefits are not clearly mentioned in the NEEAP.
Energy advice and audits	• Advice and audits are only slightly included as measures.
Information tools	• Media campaigns in radio and TV to inform about energy efficiency for housholds and end consumers.
Demonstration projects	• Not mentioned.
Education and training for stakeholders	• A training, information and consciousness-raising plan exist.
Adequacy of policy package	• The actual policy package is a first step but needs to be improved to really implement a change in the buildings energy saving policies.

Figure 28. Progress of NEEAP in Spain (EEW, 2013)

The expert interviews demonstrate a mixed result as well. Two thirds see policies rather ambitious, while the rest find level of ambition being low. 17% of interviewed experts found progress to be very little. However, most experts believe that targets are achievable due to the low level of ambition. It was highlighted that EE policies are overshadowed by the crisis, which caused a steep decrease of energy demand and lack of funding. Almost one fourth of experts see a threat to residential sector due to important gaps in Spanish EE policy : *Existing programs to improve the energy efficiency of residential buildings are scarcely used since homeowners are not obliged to. At the same time, experts are also able to name successful programs . (European Environment Agency, 2013:6).*

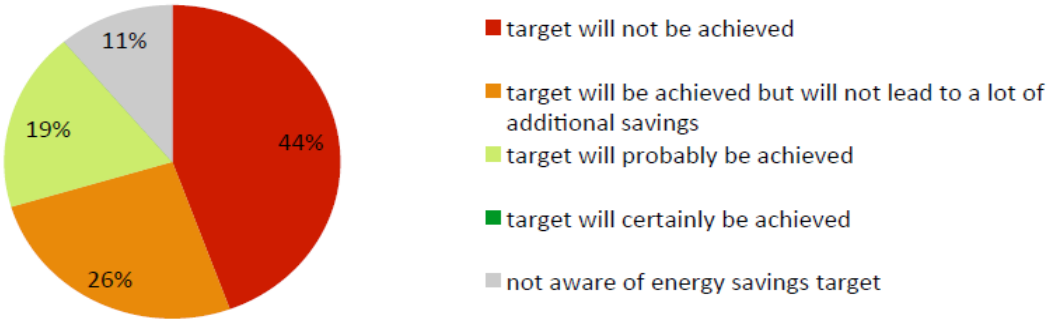


Figure 29. Spain: achievements of national energy savings target (EEW, 2013).

EPBD IMPLEMENTATION

In Spain, EPBD was implemented by three Royal Decrees from 2006-2007. The draft was proposed to the Government. However, lack of political support led to postpone the full implementation. The Energy Performance of Buildings Directive finally was transposed into Spanish law in 2013 through revisions to the legal instruments: The Technical Building Code (TBC), the Regulation on Thermal Building Regulations (TBR) and Royal Decree on the Energy Certification of Buildings. Since late implementation the main objectives were transposed including higher demand in Technical Building Code, the Regulation on Thermal Installations in Buildings and the Energy Certification of Buildings (IDAE, 2015).Two important measures were introduced in Spanish Strategy for Energy: Rehabilitation in the Building Sector and Aid programme for the energy rehabilitation of existing buildings in the residential sector.

REHABILITATION PLAN

As it was mentioned above, sustainable development is relatively new to Madrid, but ambitious goals have been set up. Through the refurbishment of buildings built before 1980 savings can be achieved almost 80% on energy consumption. Therefore, there is a demand for creating a working model that makes these actions economically viable. '*The Sustainable Development Department set up a Refurbishment Panel to discuss the current situation and the options for action with the aim of implementing a comprehensive city refurbishment programme, particularly focusing on the suburbs. Although with a delay of 2 years, in 2015 a bilateral agreement has finally been signed with the Autonomous Community of Madrid for funding for the housing scheme'* (Pereda, 2015: 46).

BARRIERS

Evidence suggests that the building sector is badly placed after the crisis (interviewee #12, #13). Experts see the main threat in existing building stock. Many residential buildings in Madrid were built after war in 1939. However, first regulations for mandatory insulation were developed in 1979. Since that time, Spain went through a building boom, which was stopped by crisis in 2008 the same time when the regulation were getting ready (interviewee #12). Since that time, not many buildings had been built. Consequently, what Spain and Madrid in particular has is a large residential building stock built before any sufficient regulations were implemented: *80-90 percent of the buildings in Spain are low quality* (interviewee #12, #13, #15). From another hand, experts see the recent recession in consumption and construction as a big opportunity to have a new start in a path leading to 2020 objectives. One can say that transition have had started.

	Before 1900		1900-1920		1921-1940		1941-1950		1951-1960		1961-1970		1971-1980		1981-1990		1991-2001	
Single Unit Houses	767.656	11%	354.954	5%	405.196	6%	435.942	7%	679.882	10%	761.201	11%	1.084.141	16%	1.096.051	16%	1.097.568	16%
Multi Unit Houses	554.412	4%	369.027	3%	498.539	4%	548.948	4%	1.305.565	9%	2.910.774	21%	3.888.633	27%	1.781.978	13%	2.282.988	16%
Total	**554.412**	**4%**	**369.027**	**3%**	**498.539**	**4%**	**548.948**	**4%**	**1.305.565**	**9%**	**2.910.774**	**21%**	**3.888.633**	**27%**	**1.781.978**	**13%**	**2.282.988**	**16%**

Table 4. Total dwellings by type of building from different periods. (Valencian Institute of Building, 2011).

	Before 1900		1900-1920		1921-1940		1941-1950		1951-1960		1961-1970		1971-1980		1981-1990		1991-2001	
Single Unit Houses	767.656	11%	354.954	5%	405.196	6%	435.942	7%	679.882	10%	761.201	11%	1.084.141	16%	1.096.051	16%	1.097.568	16%
Multi Unit Houses	132.086	7%	71.292	4%	91.147	5%	102.782	5%	205.484	11%	327.792	17%	418.935	22%	262.965	14%	318.342	16%
Total	**899.742**	**10%**	**426.246**	**5%**	**496.343**	**6%**	**538.724**	**6%**	**885.366**	**10%**	**1.088.993**	**13%**	**1.503.076**	**17%**	**1.359.016**	**16%**	**1.415.910**	**16%**

Table 5. Total dwellings by type and year of construction. (Valencian Institute of Building, 2011).

INSTITUTIONAL BARRIERS

Discussions with experts have identified issues related to the institutional and administrative structure. Generally, experts noted shortage of political incentives. Even though the *change has started*, the main institutional barriers are insufficient regulations and ill-structured policies.

LACK OF POLITICAL WILL

Economic crisis had paralyzed the construction sector in Spain in recent years. Therefore, nowadays, the biggest issue is not new buildings but buildings that were built before regulations for energy efficiency (interviewee #12, #13, #17). There is a demand for urgent rehabilitation: *Millions of buildings have nothing related to EE (interviewee #17). A paradigm shift in the sector of construction is necessary. To convert buildings we need to change the model of construction sector. Before the crisis, around 800,000 new buildings were built per year! Maybe all of Europe has not built this large number of new dwellings. However, all these*

buildings were constructed without considering energy efficiency (interviewee #17). Unfortunately, rehabilitation is not an easy process: *You want to do things right but lack of financial sources of inhabitants (interviewee #17).*

However, change had started. The regulations changed with new building code in 2013 and an update is planned in the year of 2017 and 2019 answering EU 2020 requirements. Experts believe that change should not be radical and Spain had chosen a strategy of *changing the regulations in a progressive way, so the sector can adapt* (interviewee #17). For example, the delay of NZB[3] formulation was explained as the unwillingness to define it before the maximum potential would be found: *we want to reach, not define NZB* (interviewee #17).

As the discussion moved toward reaching the objective of 2020, opinions have split. Some experts believe that the right path will be found and the targets will be achieved: *2020 is not a reaching point, it is a starting point. We have a lot commitment in renewable energy. We have to do this. Renewables Industry is working on it, professional field is working on it* (interviewee #17, #13, #14, #18). From another hand, experts skeptical about meeting the objectives of 2020 (interviewee #12, #15, #16). Although, they see a big potential in renewables, they argue that the paradigm shift in industry is needed. '*Architects and engineers need to change their values towards consideration or even prioritizing EE; constructions need to use sustainable technologies' (interviewee#12).*

LAX REGULATIONS

All experts cited inefficient Energy Performance Certificate (EPC) as an example of a barrier related to lax regulations. EU obliged Member States to introduce building EPC as a tool addressing disclosure of the building energy performance in order to increase the awareness and integrate this data into real estate decision-making agenda. In Spain EPC is known as *Certificado de Eficiencia Energetica* (CEE), which came into force in June 2013. Each property is being scored ranging from A (extremely efficient) to G (particularly inefficient). The regulation is obliged to disclose energy performance information at the time of sale or rent a dwelling. Although the idea seems to be a useful tool with potential to incentivize efficiency improvements, in Spain people did not understand the objective of the certification process and consequently the procedure became an empty formality for

[3] NZB (Nearly zero-energy buildings) buildings that have very high energy performance. The low amount of energy that these buildings require comes mostly from renewable sources. The Energy Performance of Buildings Directive requires all new buildings to be nearly zero-energy by the end of 2020. All new public buildings must be nearly zero-energy by 2018. EU countries have to draw up national plans to increase the number of nearly zero-energy buildings (Retrieved from: http://ec.europa.eu/energy/en/topics/energy-efficiency/buildings/nearly-zero-energy-buildings).

them (interviewee #12, #17). EPC is being perceived as an extra tax among building decision-makers (interviewee #17).

Furthermore, there is a common opinion of the EPC field *for being corrupted, cheap and unable to function properly* (*interviewee* #12). An expert from IDEA explained it as a consequence of crisis that generated emergence of *fake companies running business on providing low-quality cheap certifications* (*interviewee* #14). Gathering these facts, it is easy to deduce that the potential of EPCs in not being fully used: *'probably just hard to prioritize: if you can pay less and get certificate D and get along with this '(interviewee #12)*. New residential buildings rarely aim high rank, only if the developer is a big company seeking for a *top mark in marketing purpose to build the greenest building (interviewee #12)*. It was noted by interviewees that there is a demand for an inspection to make an EPC a better tool (interviewee #12, #14, #17).

ILL-STRUCTURED POLICIES

Solar panels boom in 2006-2008 was reported as an example of ill-structured policy. It was unprecedented boom in the deployment of solar photovoltaic (PV) modules,[4] due to the large part to a generous feed-in tariff (Rio & Mir-Artigues, 2014).

Consequently, it led to a spectacular boom as the government insisted to reduce the unsustainable costs of the tariff. The purpose behind the policy was to increase the share of renewables by expanding installation of solar PVs. This objection had been gradually achieved in the beginning. Nevertheless, poor policy design induced speculation to step in and resulted in failing to control costs. The study explains how a number of consequent facts defected the future prospects of ratepayer-funded solar panels installation and in a way deteriorated the domestic industry (Rio & Mir-Artigues, 2014). Eventually, policy changes that were considered retroactive were made, infuriating investors and bringing criticism in policy making community. The figure from the study of solar panel boom in Spain illustrates dramatic story of massive raise in deployment in 2008 and demonstrates following reduction (Rio & Mir-Artigues, 2014).

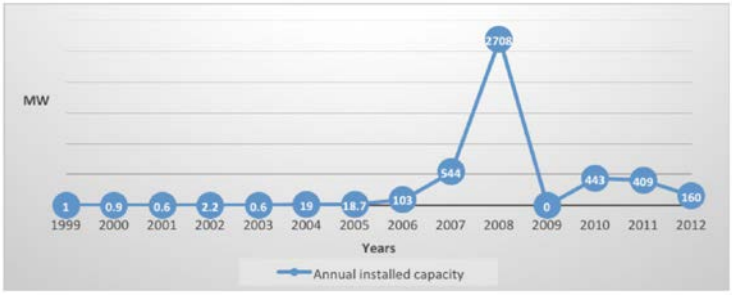


Figure 30. Spain's annual installed solar PV capacity (Rio & Mir-Artigues, 2014).

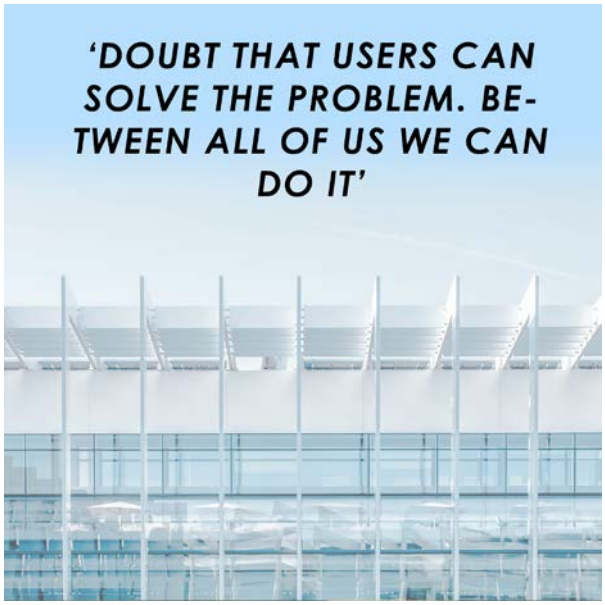
[4] Photovoltaics (PV) is the name of a method of converting solar energy into direct current electricity using semiconducting materials that exhibit the photovoltaic effect. A photovoltaic system employs solar panels composed of a number of solar cells to supply usable solar power.

Experts argue that policy only worked and supported those who had a chance and resources to install PV. As the government was clearly giving money to everyone who installed solar PVs, the objection shifted from alertness of sustainability to getting quick money by random installation of solar panels (interviewee #15). Very soon, public money started simply floating to private organizations or individuals. Additionally, an expert from a construction research institution argued that technically the industry was not prepared, and therefore in many cases PVs were low quality and got a bad reputation (interviewee #12). Moreover, although the policy was good for the photovoltaic industry for some while, nowadays there is no obligation to control or update them now (interviewee #17).

MARKET BARRIERS

STAKEHOLDERS COMPLEXITY

Multi-agent failures or actors complexity implies the diversity of stakeholders involved and lack of coordination between them (Delarue, Meeus, & Azevedo, 2013). As EEB in urban areas is being governed by multiple public and private actors, the complexity of decision making arrangements is growing. The EE of the building industry in Madrid was characterized by being highly fragmented (interviewee #12, #13, #15,#16, #17). The lack of coordination between government, architects, engineers, developers, financiers, building managers, occupants and owners was cited as a big barrier: *there is a gap incoordination, actors should share responsibilities-obligations and benefits to reach the EE (interviewee* #12).



'We need more coordination: responsible administration to work together, Ministries need to sit together. Need EE line that goes through all the ministries and sectors, professionals, consumers. Everything that happens in the country related to energy. Could be useful to have one coordinating EE ministry and all the ministries to hang below (interviewee #17).

To reach better coordination it was suggested to identify all the actors, their roles and responsibilities, set the planning time, create new transparent financing mechanisms and establish communication (interviewee #17).

When speaking of retrofitting the existing building stock, the importance of coordinating neutral actor was noted: *'The rehabilitation is a complicated and also emotional process - people need to trust, there might happen a gap in resources in the middle of the process, there will be a need to include bank, etc. The process of rehabilitation is so long. May take up*

for 2 years with all the administrative procedure. It is necessary to have a neutral actor to control the whole process from the beginning until the end (interviewee #17).

Interestingly it was proposed by an expert from consultancy group to have as a coordinating actor an architect from professional college Colegio de Arquitectos.[5] In general, the idea was supported by the unique position of architects in Spain: '*In Spain, architecture is global. Architects have very diverse vision and studies cover both technical and social sides' (interviewee #17).* The consultancy company hold the project with a professional college and believe that architects from Colegio de Arquitectos could be relevant actors to control the whole process of rehabilitation. The opinion was supported by range of factors. For example, the professional college is suitable due to being a public body because people would not have trust in representatives from private entities. Moreover, it would be better to make it obligatory to include this neutral coordinating actor. In Madrid there are about 10,000 registered at the college as professional architects (interviewee #17).

AWARENESS RAISING DEMAND AND POOR MARKETING INCENTIVES

Main problem is that it is not as if we need to update or upgrade information, but we need it from zero, no knowledge at all in Spain. Not only users, but also technicians need to be prepared (interviewee #17).

The interviews with experts have indicated a big gap in knowledge of EEB and demonstrated an urgent demand for dissemination and awareness raising. Some experts were involved in the programs aiming at awareness raising.

For example, Consulting Group Grupo Tecma Redis is the first and biggest media group for sustainability and constructions in Madrid. This communication group has a mission to inform and generate knowledge about energy sustainability and technologies in the building sector. There are five people constantly updating internet portals (intelligent buildings, sustainable construction, energy efficiency, smart city and smart grid) through which group reaches about 100,000 professionals each month. They also hold annual congresses with ministries; public and private actors, where they run round tables, discussions about targets and achievements, and demonstrate new solutions (interviewee #17).

The expert from Innovation Research Department within Municipal Housing Enterprise, known as *Empresa Municipal de la Vivienda y Suelo* (EMVS) described a variety of programs including programs at EU level aiming EE and retrofitting awareness raising. For example,

[5] Colegio de Arquitectos-professional architectural college where newly graduated from architecture school students can achieve a license that provide recognition as an architects.

there was a project conducted in public markets in different districts of Madrid, where promoters were giving out brochures. However, only small part of the population could be reached this way: *Needs to be done through different scale (interviewee #16).*

'In Madrid awareness is the biggest problem, because we are quite far from where we have to be now. We need to be more advanced, 2020 is coming' (interviewee #17).

The problem that regulations were implemented late. Partly due to the crisis, another part is low priority – result of low understanding. Expert mentioned that they preparing strategies to educate and *inform technical stuff in order to involve them in the 2020 path* (*interviewee* #17).

Expert from IDAE elaborated on parts of NEEAP that are dedicated to marketing campaigns through TV, Radio, internet, newspaper about renewables, efficient mobility, rehabilitation, etc. (interviewee #14). However, there is a criticism towards this marketing incentives and design, due to the low results/outcome (interviewee #16, #17): *Most information on the Internet is through IDAE, has a very useful content. But I consider missing lead by example by reducing public spending on glitz and increasing investment in energy rehabilitation. I would also mention the curiosity IDAE's website, as well as most of the websites on energy efficiency of public administration, not adapted to the screen of a mobile or a tablet, do not have responsive design (interviewee #17).*

Many experts have noted lack of good marketing behind EE and buildings retrofitting as a barrier: *The systems are okay, we have technical solutions, and the problem is more the lack of knowledge about the solutions. People do not care to spend 800 euro for an iPad, but for a window it's too much (interviewee #12).* There is a demand for better marketing. Strategies that will bring EE solutions closer to public and youth. However, from one side it is a technical challenge, which needs a solid investment: *maybe in future, but until now no money for that (interviewee #17).*

A very interesting uptake on this problem was received from an NGO representative. He explains that the delay of EPBD is a problem of cooperation between government and companies behind. He believes that big companies govern the media and different sectors, including building sector. They promote renewables in a bad light: too expensive, useless, etc. : *From the 12 biggest companies in the world, 9 are in energy. Not clean energy. Laws are written by big companies. Companies press government and market, therefore all we hear is: "renewables are expensive, they are not working"* (*interviewee* #15).

LACK OF TRAINED PROFESSIONALS

Evidence from interviews indicated the lack of awareness, knowledge and competence in industry professional fields (interviewee #12, #16, #17). There is a common prejudice regarding the costs of renewables. Statement from the expert of housing agency amplifies the opinion on EE costs and following consequences of that: '*Business as usual. We are not going to change quickly. Even people in construction think any energy performance is costly unfair. So for them it's easier to do the way they used to work' (interviewee #16).*

Skill shortages exist in professional market. It is noteworthy that many experts reported lack of educational programs aiming to overcome the barrier and promote the EE knowledge: *Regarding new buildings, it should be easier but bigger barrier here that it is not enough included in education system. Probably most of the current architects did not have it in their education and they lack of environmental concerns. However, the young generation is better (interviewee #12).*

Additionally, it was noted that there are many legislation barriers that need to be overcome in order to fully integrate sustainability in education: *In Spain the problem is that there are too many ministries with different competences. It is a global concept of climate change that needs to be integrated. EE actually is a field that is improving quicker nowadays. Anyway, there is a strong demand for better education. And time is needed to change mind-set (interviewee #17).*

LOW INCOME AND ENERGY POVERTY

Expert interviews have identified a number of barriers in financing. Not surprisingly, all conversations were around energy retrofits (interviewee #12, #14, #15, #16, #17). The key barriers seems to be high upfront costs and lack of available resources or external finance.

Due to the lack of awareness and knowledge, that was discussed in above, experts highlighted prominent perceptions that energy efficiency investments are financially risky and financial returns from EE are non-existent or null: *The agents of the sector lack knowledge too. For example, they do not know about payback options and timing for energy refurbishment (interviewee #12).*

Upfront cost and lack of resources are major barriers to improving energy efficiency in buildings. EE improvements in existing buildings require upfront investments while the benefits accrue over many years (Becqué et al., 2016). However, for building owners a lack of available savings or external finance seem to be a big barrier in Madrid. Relevant literature suggests *that buildings with poor energy efficiency are often inhabited by tenants or owners who impede retrofit activities due to their socio-economic conditions. As a further consequence, those households with a low net-equivalent income are also at risk of energy poverty (Weinsziehr et al., 2016:1).* Study refers to fuel poverty research, which concludes that low-quality high energy consumed buildings overlap with low-income households (Weinsziehr et al., 2016).

Experts confirm that low availability of financial resources that prevent upfront investments are often directly related to household incomes (interviewee #12, #15, #16, #17). Besides, *energy poverty* phenomenon occurs: *When we do the simulations and calculations we always think that there is energy demand in the building, so people are in the comfort levels and they consume energy, but in reality it's not always like this. There is an energy poverty and people don't live in the comfort level and they won't use energy even if they retrofit. Theoretically, you can get investment in insulations facade and you will get your money back because they will save money on heating. But if you don't use heating because you don't have money, then you wont get the money back (interviewee #12).*Further, an expert from an NGO claimed that

approximately 20% in Spain, even the middle class, is being affected by energy poverty (interviewee #15). Downscaling to Madrid region, there are more likely renovations to happen within the city core because it is an inversion and the value will only increase, however in periphery zones, the conditions are worse and payback time is longer. '*With energy poverty there is no payback. No company wants to work and invest with degradation areas. It is a big threat, in 20 years the situation might become dangerous. We will have problem with these people. Not just EE but outdated materials, accessibility, etc.* (*interviewee* #17).

POOR FINANCIAL MECHANISMS

Consequently, interviewees ascertained poor quality of financial mechanisms and lack of funding for projects, reluctance to take loans and the reluctance to take out loans form the main barriers for homeowners. '*Financial institutions are not prepared to finance the rehabilitation or energy efficiency. They must change the funding model. They are still in the model that led us to the mortgage crisis and do not know how they work this type of project'* (*interviewee* #15).

Mechanism should work between government-banks-users. Banks should give loans to retrofit, but it is hard here because all the building inhabitants must agree to retrofit the building. Property law need to be updated, so banks will be able to finance (interviewee #12).

To improve the situation, applying ESCO companies was suggested: *Banks are not ready yet. Maybe ESCO companies that do the inversion would work, where you pay from your savings. We need to solve social problems. Maybe solving them with including EE (interviewee #15).*

END-USER BARRIERS

LACK OF KNOWLEDGE

Evidence suggests that big gap in knowledge of EE among citizen makes the awareness raising one of the biggest challenges (interviewee #12, #15, #14, #16, #17). As it was mentioned above, people are unaware *because no info comes from government, even politicians do not know* (*interviewee* #15). Even if they were aware, there is a grounded concept that it EE solutions are too modern and cost more and people do not want to spend any extra, especially after crisis (interviewee #12).

Moreover, it was mentioned that it is harder to involve and convince multi-family or collective housing typology, because the decision has to be made by building community and *there are many juridical barriers* (*interviewee* #15). In a housing community for a big building there is an administrator of the building known as *admistrator de thinkas* responsible for building management, decisions related to building renovations, etc. (interviewee #16).

An expert from consulting group Grupo Tecma Red suggested informing collective housing typology through building maintenance inspections. The Evaluation Report of Buildings came into force In June 2013 and aims to: '*Assessment of the conservation status of the building and*

Evaluation of the basic conditions of accessibility, establishing whether the building is susceptible or not to perform reasonable accommodation' (*interviewee* #17). It is an obligation in Madrid to check the building and multi-family building communities obligated to pay for it. For example, if building is in need to rehabilitate the façade, the company can influence by suggesting EE solutions and even promote financial schemes (interviewee #17).

In 2016, the Madrid city authority established the Proximity Offices in which professionals from different sectors accompany residents during the information and application process for funding: *These offices also mediate with the regional authorities to achieve residents' agreement so that the necessary improvements works can be implemented. It is necessary to change the opinion that residents have of funding that in many cases is unsuccessful and at times not even forthcoming* (Pereda, 2015: 45). The project is called Energy Saving Service and Rehabilitation (SAER) or Oficina del Servicio de Ahorro Energético y Rehabilitación. It is a collaboration between the municipal housing and land Madrid EMVS and the association of companies. Experts responded positively on SAER: *'Project is a point of advice and assistance to citizens offering practical and simple information on how to upgrade homes and buildings through good practices and energy rehabilitation. It is always positive to bring information to citizens in their surroundings' (interviewee* #16); *'Useful to be near the citizens…there is a potential in private-public partnership'* (*interviewee* #17). *However, there are doubts regarding costs of office maintenance and success in involvement regular people without high quality marketing* (interviewee #15).

LACK OF MOTIVATION

There is a saying about southern people's mentality, meaning that historically people in South spend more time during their life outdoors. Interestingly, a representative from a research Institute in Construction referred to it while discussing the ways to influence people: *In Spain the renovation should be mandatory. Because we do not have our culture to take care of the building from outside* (*interviewee* #12).

Few interviews touched upon a matter of confidence when decision-making. As it was mentioned above, there is a demand of trust for people to invest and let the changes in their homes: *consumers need to trust you (interviewee #17).* Furthermore, expert from Non-governmental Organization Ecologistas en Acción believed that the demand for trust rooted in mentality, which he relates to historical changes of regimes: *'People in Spain bear anxiety and mistrust as a conscience of transition. It is hard to influence them and hard to create a community as a result of dictatorship regime'* (*interviewee* #15).

SOCIO–ECONOMIC ISSUES

Speaking about motivation of public in involvement and interest in EE of the houses most of the interviewed experts finalized by alleging to the socio-economic issues. It seemed that there are range of conditions affecting the decision-making process. For example relevant age: *Old people they don't care. They are not willing to spend their money on renovation (interviewee #15).* However, almost all experts concluded that *problems need to be solved for the whole society. The government needs to give help (interviewee #15); government should take into account social level, direct aids' (interviewee #17).*

Table 6. EEB barriers in Copenhagen and Madrid.

COPENHAGEN

MADRID

INSTITUTIONAL BARRIERS

PARADOX EFFECT OF REGULATIONS	LACK OF POLITICAL WILL
ILL-STRUCTURED POLICIES	LAX REGULATIONS
LACK OF POLITICAL WILL	ILL-STRUCTURED POLICIES

MARKET BARRIERS

STAKEHOLDERS COMPLEXITY	STAKEHOLDERS COMPLEXITY
SKILLS GAP	LACK OF TRAINED PROFESSIONALS
PROBLEMS OF COMMUNICATIONS	AWARNESS RAISING DEMAND AND POOR MARKETING INCENTIVES
LACK OF UNDERSTANDING OF FINANCIAL SCHEMES	LOW INCOME, ENERGY POVERTY
IST RISKS AND UNCERTAINTY OF NEW TECHNOLOGIES	POOR FINANCIAL SCHEMES

END-USER BARRIERS

LACK OF PRIORITIZING ENERGY VALUE WHEN PURCHASING A PROPERTY	LACK OF KNOWLEDGE
BARRIERS IN DECISION-MAKING PROCESS	LACK OF MOTIVATION
REBOUND EFFECT	SOCIO-ECONOMIC ISSUE

4.2 PART II. ASSESMENT BETWEEN WICKED, TAME AND CRITICAL PROBLEMS

The previous part demonstrated the findings. The barriers were determined and formulated. This part of the analysis looks at the nature of the problems and distinguishes findings into categories of *Tame, Wicked* and *Critical problems.* To categorize findings I use the knowledge and vocabulary from the theoretical foundation where there is a solid explanation of the characteristics of each type of problem. In short, a *Tame problem* is resolvable, despite being complicated, it is most likely had occurred before and needs an unambiguous management approach. A *Critical problem* has self-evident nature and lacks the uncertainties in solution, consequently requires evident solution. A *Wicked problem* is more complex than complicated, it has not occurred before and requires an extensive approach to address the solution (Grint, 2008:11).

In the table below the barriers were color-coded after problems type. Purple represents wicked problem, green – tame, yellow- critical. However, the analysis has not determined any critical problems in my findings.

Table 7. EEB barriers in Copenhagen and Madrid. Assessment between wicked and tame problems.

COPENHAGEN

MADRID

INSTITUTIONAL BARRIERS

COPENHAGEN	MADRID
PARADOX EFFECT OF REGULATIONS	LACK OF POLITICAL WILL
ILL-STRUCTURED POLICIES	LAX REGULATIONS
LACK OF POLITICAL WILL	ILL-STRUCTURED POLICIES

MARKET BARRIERS

COPENHAGEN	MADRID
STAKEHOLDERS COMPLEXITY	STAKEHOLDERS COMPLEXITY
SKILLS GAP	LACK OF TRAINED PROFESSIONALS
PROBLEMS OF COMMUNICATIONS	AWARNESS RAISING DEMAND AND POOR MARKETING INCENTIVES
LACK OF UNDERSTANDING OF FINANCIAL SCHEMES	LOW INCOME, ENERGY POVERTY
IST RISKS AND UNCERTAINTY OF NEW TECHNOLOGIES	POOR FINANCIAL SCHEMES

END-USER BARRIERS

COPENHAGEN	MADRID
LACK OF PRIORITIZING ENERGY VALUE WHEN PURCHASING A PROPERTY	LACK OF KNOWLEDGE
BARRIERS IN DECISION-MAKING PROCESS	LACK OF MOTIVATION
REBOUND EFFECT	SOCIO-ECONOMIC ISSUE

Paradox effect of regulations tends to be a tame problem because it requires a proper management to solve it. For example, considering the specificity of the unique Copenhagen energy systems when implementing EPBD. The problem of *Poor financial schemes* in Madrid is tame too: it needs to develop more effective financial schemes, which was done before. Moreover, this example demonstrates how cases can learn from each other. Copenhagen has advanced finance schemes, essence of which could be considered by Madrid. *Ill-Structured Policies* in both cases and *Lax Regulations* in Madrid are tame because they require revision of policies based on the knowledge gained from the past and present experience.

Another tame problem is *Lack Of Understanding The Financial Schemes*. The problem requires a straightforward solution that lies in the explanation and clarification about financial schemes and payback time. However, the problem can be related to other problems such as lack of communication and lack of interest in EE. *IST Risks and Uncertainty of New Technologies* is a tame problem too. Expert interviews demonstrate that new technologies are very efficient however not yet popular due to its novelty. It requires time to be tested and spread within the market. Evidently, problem was faced before. *Skills gap* in Copenhagen and *Lack of trained professionals* in Madrid. These problems tend to be tame as well as they have a *de-ja vu* aspect, meaning solution exist as it has been solved before. If we look at many other sectors of EE they have enough well-trained professionals. It is a problem of a competent management, that needs to implement relevant subject in different fields of education.

The rest of the problems, on averse implies aspects of *vu-ja de*, meaning that there is no proven solution and they require state-of-art approach. *Stakeholders complexity* can not be easily solved by management, it is clearly requires a comprehensive approach, trial-and-error methods to find the right way to construct the ties of stakeholders involved in different phases of fragmented lifecycle of the building, considering the growing complexity of decision making arrangements. *Lack of Political Will* is wicked problem too. The research demonstrated that political incentives and decisions are being affected by many aspects, connected across the political cooperate and citizen domain. It is highly challenging for a politician to achieve the goal because each action creates a consequence on the other domains. *Lack of Prioritizing Energy Value When Purchasing a Property, Barriers in Decision-Making Process in Existing Buildings, Rebound Effect, Lack of Motivation and Knowledge* tend to be wicked as they all rooted in lack of interest. Which from one hand related to problem of communication and from the other to the lack of motivation. Either way, it is a complex issue that addresses the mentality change and awareness raising among population towards conscious care of EE. *Socio-Economic Issues* and *Low Income* are wicked problems by definition: they are long-term complex issues with range of aspects demanding changes in different sectors following unique model.

4.3 PART III. DEFINING WICKIDNESS

The previous part identified the nature of the barriers. However, I am interested in continuing the analysis with common features in order to make a sweeping assumption of nature of EEB

implementation. In other words, to synthesize the finding of two different cities towards more general European case statement. In the table below, the common barriers are listed. Intuitively, one can assume that common problems are wicked: the commonality of the problems points out to the problems that are harder to solve, as it had not been solved yet in neither cases.

My hypothesis is that problems in EEB are wicked and therefore I would like to examine these main problems to see whether they are falling under characteristics of wicked problem and to what extent. To continue the analysis, I will assess the degree of wickedness of four core areas by scoring them from one to five in each of three fundamental elements: *Agent Finitude, Normativity* and *Complexity* based on the empirical data.

Table 8. overlapping EEB barriers in Copenhagen and Madrid.

COPENHAGEN	OVERLAPPING BARRIERS	MADRID
INSTITUTIONAL BARRIERS		
PARADOX EFFECT OF REGULATIONS		LACK OF POLITICAL WILL
ILL-STRUCTURED POLICIES	LACK OF POLITICAL WILL	LAX REGULATIONS
LACK OF POLITICAL WILL		ILL-STRUCTURED POLICIES
MARKET BARRIERS		
STAKEHOLDERS COMPLEXITY	STAKEHOLDERS COMPLEXITY	STAKEHOLDERS COMPLEXITY
SKILLS GAP		LACK OF TRAINED PROFESSIONALS
PROBLEMS OF COMMUNICATIONS	PROBLEMS OF COMMUNICATIONS	AWARNESS RAISING DEMAND AND POOR MARKETING INCENTIVES
LACK OF UNDERSTANDING OF FINANCIAL SCHEMES		LOW INCOME, ENERGY POVERTY
IST RISKS AND UNCERTAINTY OF NEW TECHNOLOGIES		POOR FINANCIAL SCHEMES
END-USER BARRIERS		
LACK OF PRIORITIZING ENERGY VALUE WHEN PURCHASING A PROPERTY		LACK OF KNOWLEDGE
BARRIERS IN DECISION-MAKING PROCESS	LACK OF INTEREST AND LACK OF MOTIVATION	LACK OF MOTIVATION
REBOUND EFFECT		SOCIO-ECONOMIC ISSUE

ASSESSING THE DEGREE OF WICKEDNESS OF FOUR CORE AREAS:

1. LACK OF POLITICAL WILL

Lack of political incentives imply lack of prioritizing the EEB while creating the policy as well as lax or wrong incentives, due to many reasons. I believe that this problem is heavily rooted in *Normativity*. Research showed that depending on a country, politicians behave differently due to the difference in understanding as well as difference in opinions on EE. The comparison between Copenhagen and Madrid showed that the mentality correlates to which extent EEB is being prioritized when creating a political framework.

From another hand, the feature of *Complexity* plays a crucial role here. When it comes to EEB the efficient policy framework includes many different sectors, as economy to provide right subsidy plan, energy industry, technology, employment, etc.

Additionally, lack of efficient policy design points out to *Agent Finitude*. There is a limitation in resources of capacity as knowledge to create suitable policy design or framework. Moreover, political frameworks seems to be not creative enough to incentivize all targeted stakeholders.

2. STAKEHOLDERS COMPLEXITY

Experts in both case cities have indicated multi-actors problem. This problem could be related to *Complexity* as there is a multiplicity in stakeholders: high diversity of them and low coordination between them. There is no expertise of efficient management that can coordinate right stakeholders at right time that is a feature of *Agent finitude and Normativity*. Research showed that very often actors pin point problems to each other. I believe ignorance and lack of knowledge plays a crucial role.

3. PROBLEMS OF COMMUNICATION

This problem seems to be a result of a previous problem. As it was mentioned above, there is no know-how to strengthen the ties of market structure, politicians, research institutions, engineers, supplier-user chains, etc. This finding tends to have qualities of *Agent Finitude* due to lack of recourses and *Complexity* due to the complexity of multi-industries involved.

Moreover, despite many attempts there is any proven solution in terms of marketing. This aspect relates to Normativity as a lack of creative thinking and out-of-the-box proposals.

4. LACK OF INTEREST AND LACK OF MOTIVATION

There are many aspects of this problem. From one side it is rooted in lack of knowledge. Experts mentioned many awareness raisin campaigns. However, none of them has reached success and solved the issue. The campaigns work short-term like a diet, while awareness raising needs to be long-term interest to become a lifestyle. Moreover, to motivate people you need to target their mentality, consider social-economic side. These relates to problems of *Complexity and Agent Finitude.* There is no ready solution; there is a demand of

comprehensive state-of-art approach, which points to *Normativity*. This problem seem to go as a red thread through all findings and deserves high score in all categories.

To conclude, four core problems are wicked to certain extend. However, *Lack of Interest and Lack of Motivation* proved to have highest degree of wickedness.

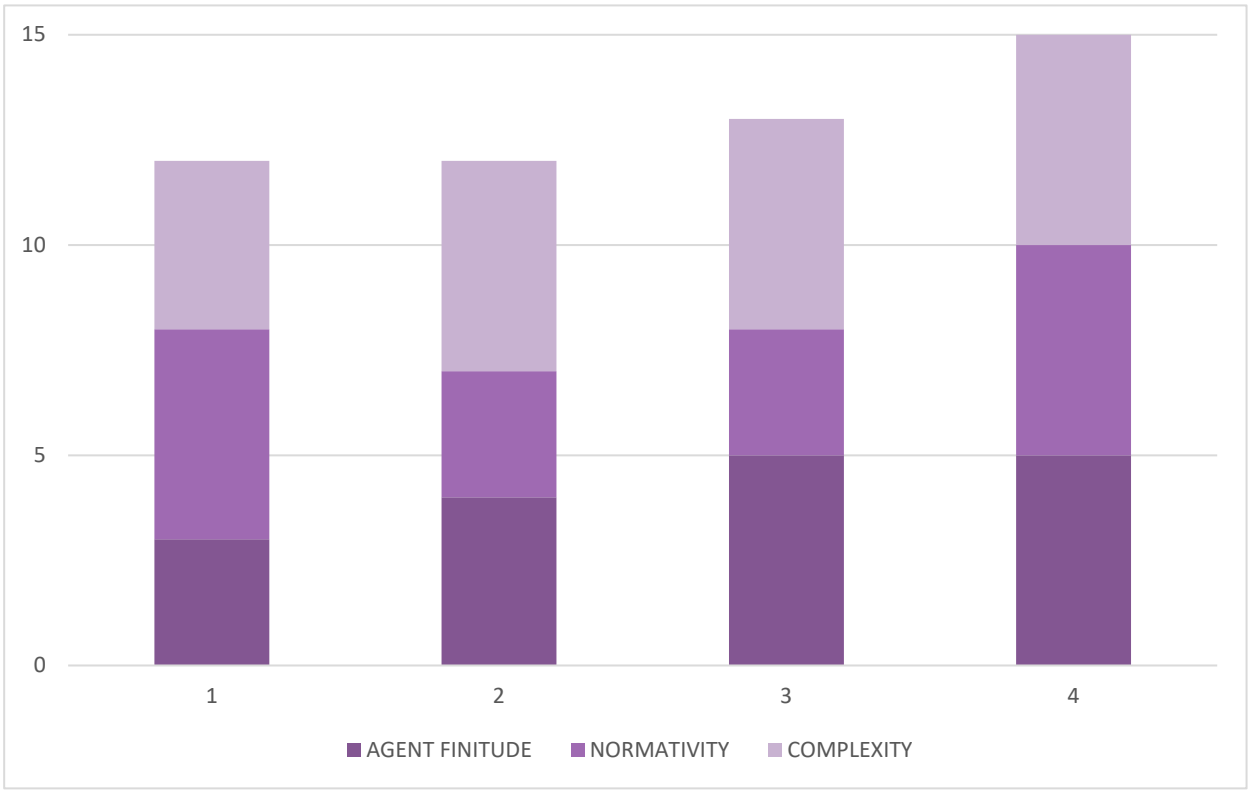


Figure 31. Assessment the degree of wickedness of four core problems

DISCUSSIONS AND RECOMMENDATIONS

5. DISCUSSIONS AND RECOMMENDATIONS

The analysis revealed that it was possible to identify specific barriers to EEB in both Copenhagen and Madrid that prohibited the implementation and acceleration of more energy-efficient building solutions. These barriers were articulated by the interviewees, as well as supported by the secondary data, which together shaped the discourse on EEB in each city. In more discursive terms, the discourse on EEB was analysed in terms of the little d discourse, as expressed through the quotes from the interviewees, which therefore represented their temporary fixation of meaning within a particular domain, in this case the domain of EEB. In their attempt to describe this domain, the interviewees attempted to fixate meaning around the subject of “buildings” in order to make sense of the challenges related to the aspects of energy efficiency.

The word “building” is in itself just a sign in the language system, as mentioned in the theoretical part of the thesis. Taking the word at face value, a “building” can mean anything, it is just a sign waiting to be articulated into some form of meaning, as was done by the interviewees. As demonstrated in the analysis, such articulations took form by positioning buildings around certain understandings, what the analysis refers to as barriers, for instance by articulating buildings in a political discourse (lack of political incentives), a human capital discourse (skills gap), or an economic discourse (lack of understanding the financial schemes). The word “building” is polymesic, and its meaning depended on how it became articulated by the interviewees.

Subsequently these barriers were further analysed in terms of their tameness or wickedness. Determining that certain barriers exist in each city, and demonstrating that the barriers can be classified as either tame or wicked problems, is interesting to the extent that it explains what these barriers consist of, and to what extent they can be assumed to be solved or managed. The barriers identified for each city can thus be understood as the foundation for further analysis, which enabled the identification of a number of overlapping barriers between the two cities (Lack of political incentives, Stakeholders Complexity, Problems of Communications, and Lack of Interest and Motivation), as highlighted in the analysis through the overlapping discourse.

Precisely the overlapping discourse is an interesting area to investigate further, and thus forms the basis of this chapter on discussion, because it opens up for reflection around why two very different cities, each with their own policies, solutions and citizens, still face the same barriers to implement EEB, and whether common solutions could be applied to the benefit of both cities, or cities in general, as a means to close the energy efficiency gap currently faced in a global perspective.

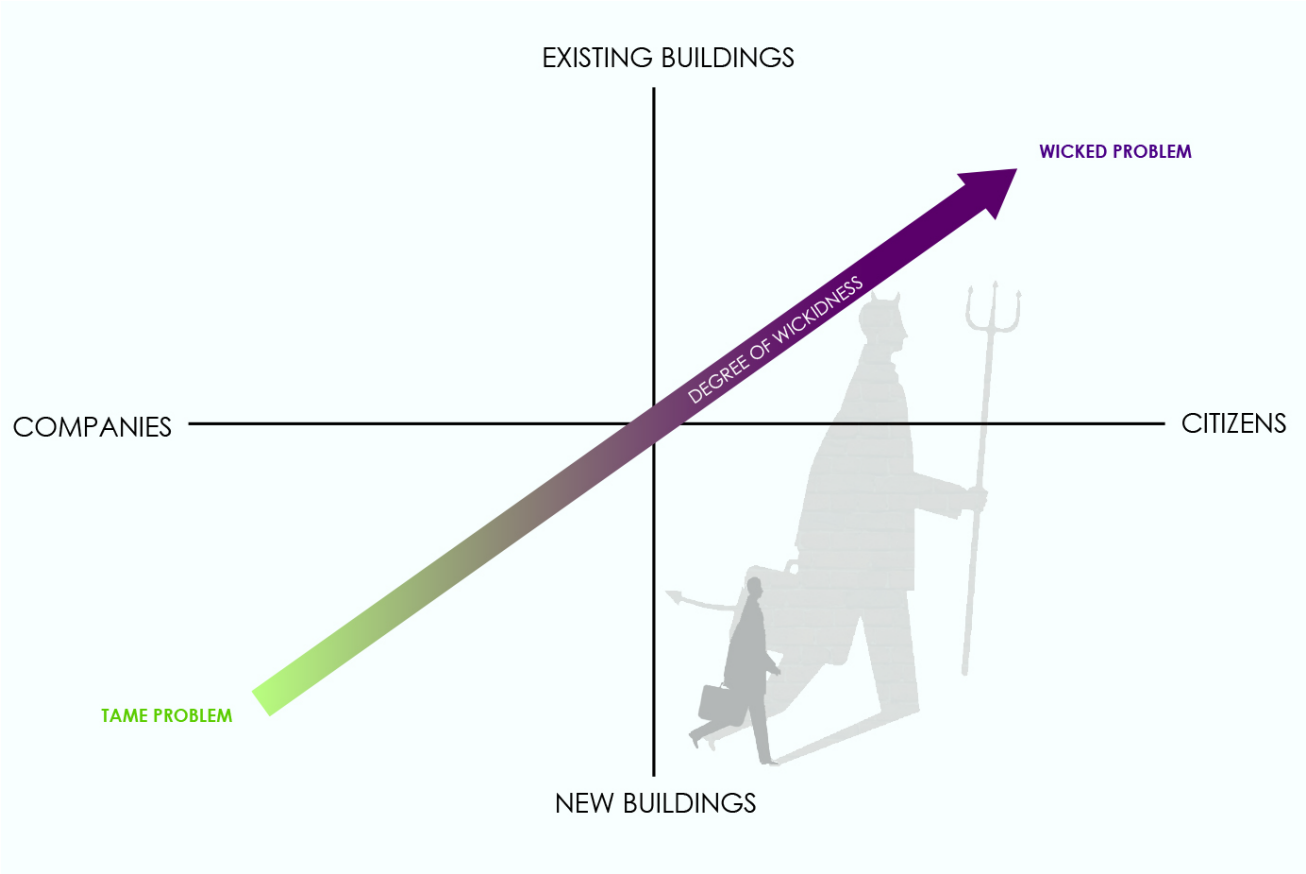


Figure 32. Four core areas of EEB.

In order to commence with this discussion, an illustration has been made that outlines the main elements (companies, citizens, new buildings, existing buildings) that were articulated in order to address the barriers under the overall, big D discourse on EEB. These main elements can be understood as the little d discourses, or domains of meaning, that were articulated by the interviewees when they made sense of the word “buildings” in relation to the barriers of EEB.

Furthermore, based on the analysis of tame or wicked problems, the illustration also shows how some elements are largely associated with barriers linked to tame problems, for articulations on ‘Companies and New Buildings’, whereas others are heavily articulated in the context of wicked problems, for instance articulations on “Citizens in Existing Buildings”. As an example, it is far more challenging, or wicked, to have citizens find the incentive and accept to retrofit their existing homes, than it is for a company to deploy their solutions in a new building.

Therefore, from an overall perspective, one can claim that in order to implement solutions for EEB, a distinction is made between new and existing buildings, and between companies and citizens to either implement or accept EEB solutions, regardless of the city in question, which is largely affected by policy frameworks and incentive structures. This falls in line with the four main barriers identified as the overlapping discourses between Copenhagen and

Madrid, which were are all represented by the articulations from the interviewees: 1) Lack of political incentives, 2) Stakeholders Complexity, 3) Problems of Communications, and 4) Lack of Interest and Motivation.

With the knowledge of these four main barriers, as well as an understanding of the area that is most wicked to address (Retrofitting existing buildings for citizens), it seems reasonable to commence the discussion by approaching these elements through the lens of the Clumsy Solution Model.

CLUMSY SOLUTIONS FOR SOLVING WICKED PROBLEMS IN RETROFITTING

EXAMPLE OF LACK OF INTEREST AND LACK OF MOTIVATION BARRIER

After the main wicked barriers were identified and the most problematic area of EEB was determined I would like to propose a problem solving approach based on the Wicked Problem Solving theory. In the following, the clumsy solution approach will be applied to Lack *of Interest and Lack of Motivation* barrier, as the analysis showed, that it is the most wicked barrier in a retrofitting area.

In short, the *Clumsy Solution Model* implies collaboration between three main cultural archetypes: *Hierarchy, Individualism* and *Egalitarians*. Each group has its own vision and problem solving approach. Each solution has weaknesses and addresses only one element of wicked problem. Therefore, wicked problems cannot be solved by local approaches because they lie outside and across cultures.

Hierarchy culture described as a group with strong bonds between people and varied interpersonal differences. Hierarchists are good at decision-making, but weak at innovations. This group represents government and politicians. Individualism implies significant similarity between people but low bond between them. They are innovative but once market fail, they lose everything. This type represents market: private companies, technology and consultancies. The final is Egalitarians category, in which people have strong bond and similarities between each other. Egalitarian culture described as ideal utopia for small groups with high community sense. Egalitarians are good at generating debate, but cannot reach decisions; they implied NGOs, activists groups and communities closer to public.

Clumsy Solution aims to combine into one system all three modes of understanding and mediate the collaboration, with possible benefits for actors. It implies sensitivity to the needs from all the actors that must be brought together into the *Clumsy Solution Space* in order to answer the problem in the case of retrofitting.

‘Doubt that users can solve the problem. Between all of us we can do it’ (*interviewee* #12).

HIERARCHISTS

As hierarchists represent government, they have access and power to political decision-making arrangements. The empirical data showed the strong necessity for education of

professionals in the fields of renovations and retrofitting as well as towards increasing the agenda of EE for the public in general (schools, universities, etc.): *Big barrier here that it is not enough included in education system. Probably most of the current architects did not have it in their education and they lack of environmental concerns (interviewee #12). There is a strong demand for better education.Not only users, but also technicians need to be prepared (interviewee #17). 'Architects and engineers need to change their values towards consideration or even prioritizing EE; constructions need to use sustainable technologies' (interviewee #12).*

Also, the need for a better communication strategies was highlighted: *People have all bit of pieces of information around them, but it's not good together in a package* (*interviewee* #3). *For regular consumers there is a need for easy information/data access and personal contact could be crucial.* Demand for a guidance led to a proposal of a leader, through whom the personal contact could be established.

Speaking of better marketing for retrofitting, evidently TV and radio are outdated ways to communicate and promote products: *Most information on the Internet is through IDAE has a very useful content. I would mention the curiosity IDAE's website, as well as most of the websites on energy efficiency of public administration, not adapted to the screen of a mobile or a tablet, do not have responsive design (interviewee #17).* This finding shows the demand for hierarchists to work closer with Individualists, market representatives, to establish more innovative marketing for retrofitting. For example through partnerships, stronger co-operation with private sector.

INDIVIDUALISTS

Expert interviews and secondary data reveal an urge for a better marketing, state-of-art or out-of-the-box approach. Companies need to find a way to make retrofitting interesting and existing as, for example, Apple products: *People do not care to spend 800 euro for an iPad, but for a window, it's too much (interviewee #12).* There is a need for strategies that will bring EE closer to public and youth. Example of Denmark shows the call for shifting the essence of current marketing idea: *For 30 years we have tried to convince people to save money by saving energy, but now we are trying to sell the better houses instead. And it's really what is trigging people. They have some dreams for a house, so we have to start there (interviewee #2). Here in North we more focus on indoor house. In a new investigation, it turned out that people do retrofitting not because they want to save money, but because they want to have more comfortable healthier house with better indoor climate. I think it is should be big marketing motivation (interviewee #1).* This finding leads a demand to find ways to involve Egalitarians e.g. public.

Additionally, there is a suggestion for a more transparent and educational view on energy consumption. It will make people question the consumption and increase the interest in retrofitting: *Many people don't know and don't care. People often do not know how much they pay for the heating. So when you do not know what you pay then why would you care about saving here? They take energy for granted' (interviewee #1).*

The lack of coordination in the retrofitting chain of government, architects, engineers, financiers, building managers, occupants and owners was mentioned many times. There is a demand for a better network or a consultant, with a role of a mediocre actor who will control the process from the beginning to the end (interviewee #2, #3, #11). *'We need more coordination: responsible administration to work together, Ministries need to sit together. Need energy EE line that goes through all the ministries and sectors, professionals, consumers. Everything that happens in the country related to energy. Could be useful to have one coordinating EE ministry and all the ministries to hang below (interviewee #17).*

Interestingly it was proposed for a Madrid case by an expert from consultancy group to have an architect from the professional college Colegio de Arquitectos as a coordinating actor. In general, the idea was supported by the unique position of architects in Spain: '*In Spain, architecture is global. Architects have very diverse vision and studies cover both technical and social sides' (interviewee #17).* The consultancy company hold the project with a professional college and believe that architects from Colegio de Arquitectos could be relevant actors to control the whole process of rehabilitation. The opinion was supported by range of factors. For example, the professional college is suitable due to being a public body because people would not have trust in representatives from private entities. Moreover, it would be better to make it obligatory to include this neutral coordinating actor.

EGALITARIANS

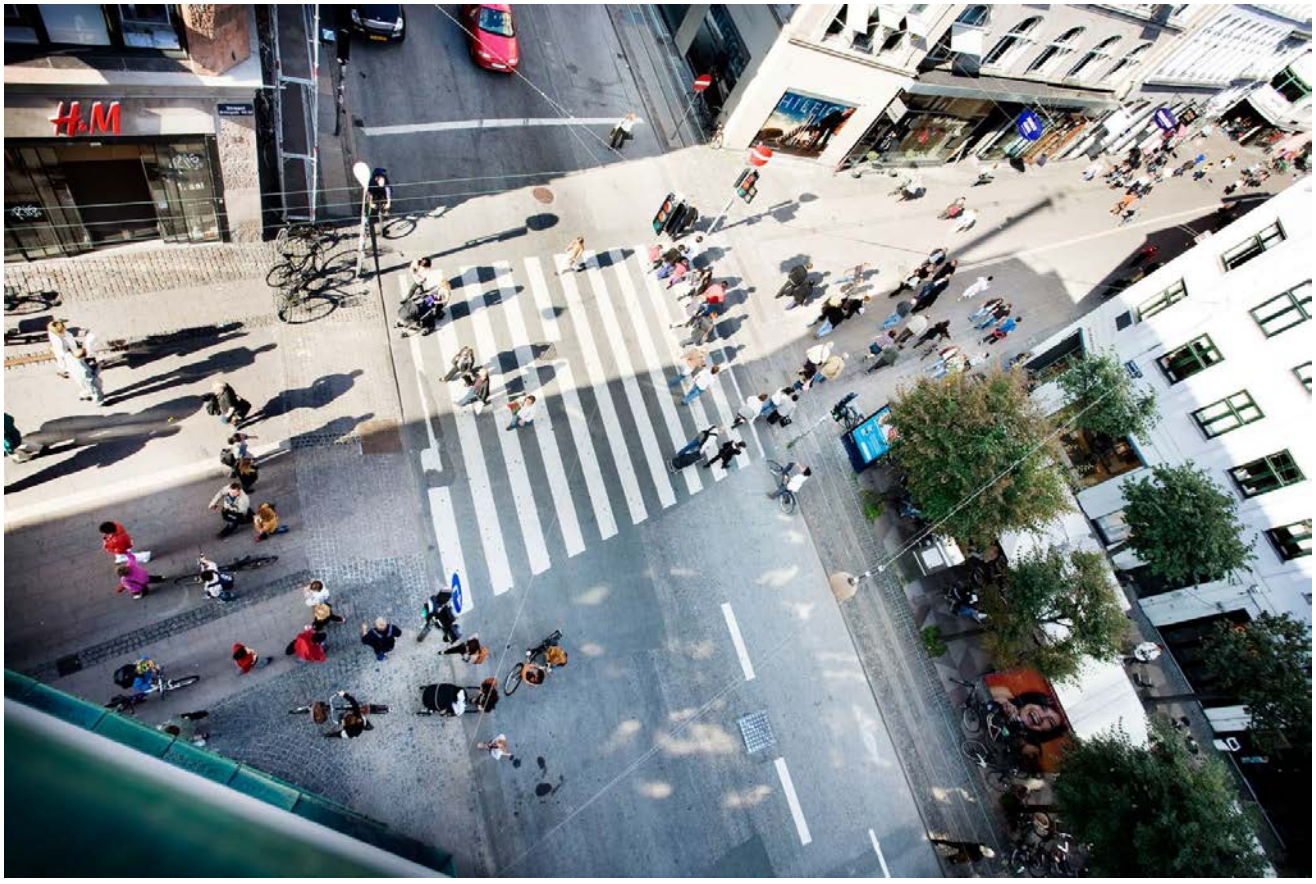
To reach a better coordination of retrofitting the existing building stock, it was suggested to find a neutral actor: *'The rehabilitation is a complicated and also emotional process - people need to trust, there might happen a gap in resources in the middle of the process, there will be a need to include bank, etc. The process of rehabilitation is so long. May take up for 2 years with all the administrative procedure. It is necessary to have a neutral actor to control the whole process from the beginning until the end. It is a coordinated process, actors on different stages of the process might have different interests' (interviewee #17).* This leads for a demand for a neutral facilitator, public representative, 'community guy' who has a trust of public: *Ideally, the initiatives should come from the actors, whom citizens trust. Like neighbors, who had experienced it already. Especially if you do a deep renovation, and your house is being remodeled, it affects your everyday life (interviewee #11).*

One expert gave a valuable advice on reaching to categories of people in particular lifetime*: 'Many people do not have time: too old, too young, just got a kid, etc. However, there are some 'windows' in your life where you are more ready for this. We need to attack them on right period. For example, when your children are moving away. You have more time and more money' (interviewee #2).* Moreover, the information should be updated regularly: *'Sometimes people are unaware. For example, we have an old family who owned the building, which they had retrofitted when they were young. Nowadays they have a very inefficient house but they do not know. So we make some campaigns as a wakeup call. When they get to know that neighbors consume 3 times less they become interested' (interviewee #5).* This proves the necessity for a trustworthy representative. People tend not

to trust government neither companies, as they are biased. Thus, the representative should be an egalitarian working with individuals and having an access to hierarchists.

Additionally, the actor could be a board from a community within private houses, social housing governing process in Copenhagen is a good example of reaching EE goals: *Social housing organization is independent neither private nor public organization. Strict regulations on democracy and ruling the building. The model is unique. Balanced rent with investments, tenants influence a decision as well. They select the board by voting at general assembly once a year. Interviews showed that this type of ownership does not have any significant financial or institutional problems in building renovations: 'Social houses, they do very successful projects. Seems they follow already 2020 standards' (interviewee # 2).*

Overall, the ideas above point a lot towards the demand for leader, someone across all three cultural archetypes, a networking actor, trustworthy for public representative, who controls rehabilitation process from the beginning to the end. This, in a way proves Grints' theory on Wicked Problem Solving as Grint argues, that leadership, not management is a right approach to solve wicked problem.



CONCLUSION

6. CONCLUSION

This thesis investigates the barriers related to energy efficiency in the building sector in two European cities. Research was motivated by the interest to uncover the energy efficiency paradox phenomenon. Although there are ambitious targets in energy reduction in the building sector and a variety of advanced technologies to support these targets, there is no evidence of significant success. Hence, the gap between actual and optimal energy use is labelled the energy efficiency paradox by scholars, and the contribution of the thesis is to provide clarity around this phenomenon by identifying and understanding the problems. Moreover, it includes recommendations to approach them.

The theoretical foundations starts with an investigation of emissions from buildings and emission reduction mechanisms concepts. Next, the theoretical part touches upon potential barriers based on previous research. This leads to analyze literature on understanding the problems related to EEB (discourse theory), defining the problems related to EEB (tame/wicked theory) and reacting to the problems of EEB (clumsy solution theory).

The empirical data is based on 17 qualitative expert interviews collected in Copenhagen and Madrid and secondary data from a European level of EEB implementation frameworks. Choice of empirical data was guided by the range of stakeholders involved in implementation of EEB. The actors were chosen from four societal areas including municipalities, private businesses, R&D institutions, and NGOs in order to create a comprehensive objective picture of the problems in EEB.

The analysis revealed that it was possible to identify specific barriers to EEB in both Copenhagen and Madrid that delay the implementation of EEB solutions. These barriers were articulated by the interviewees, as well as supported by the secondary data, which together shaped the discourse on EEB in each city and led me to distinguish findings in terms of three groups: Institutional, Marketing and End-User problems. Under these categories, 10 specific barriers in each case city were formulated.

The following step of the analysis evaluated and coded barriers in terms of the problem nature into Wicked, Tame and Critical. In order to explain the logic of the coding each problem evaluation was being briefly described. Determining that certain barriers exist in each city, and demonstrating that the barriers can be classified as either tame or wicked problems, is interesting to the extent that it explains what these barriers consist of, and to what extent they can be assumed to be solved or managed. After, common barriers were identified and synthesized, shaping an overlapping discourse of more general European level barriers (Lack of political incentives, Stakeholders Complexity, Problems of Communications, and Lack of Interest and Motivation). Subsequently these barriers were further analysed in terms of wickedness magnitude in order to answer the last research question.

In order to commence with the discussion, an illustration was proposed that outlined the main elements (companies, citizens, new buildings, existing buildings) that were articulated in order to address the barriers. Therefore, from an overall perspective, one may make the claim that in order to implement solutions for EEB, a distinction is made between new and existing buildings, and between companies and citizens to either implement or accept EEB solutions, regardless of the city in question, which is largely affected by policy frameworks and incentive structures. The model shows, that the most challenging, or wicked area is retrofitting as it requires citizens to find the incentive and accept to retrofit their existing homes. This falls in line with the four main barriers identified as the overlapping discourses between Copenhagen and Madrid, which were are all represented by the articulations from the interviewees: 1) Lack of political incentives, 2) Stakeholders Complexity, 3) Problems of Communications, and 4) Lack of Interest and Motivation.

With the knowledge of these four main barriers, as well as an understanding of the area that is most wicked to address (Retrofitting existing buildings for citizens), it seems reasonable to commence the discussion by approaching these elements through the lens of the Clumsy Solution Model. The theory and analytical perspective enabled the example of clumsy solution approach to the most wicked challenge Lack of Interest and Lack of Motivation. The proposal addresses how each of the three participating social groups can contribute to solution of identified barriers in EEB and recommend the ways to establish collaboration between them.

LIST OF ACRONYMS

AACC: Autonomous Communities

EC: European Commission

EE: Energy Efficiency

EEB: Energy Efficiency of the Buildings

EPBD Energy Performance Building Directive

EPC Energy Performance Certification

EMVS Municipal housing company and land

EU: European Union

GDP: Gross domestic product

GHG : Greenhouse Gas

NEEAP National Energy Efficiency Action Plan

NREAP: National Renewable Energy Action Plan

NZB: Nero Zero Building

IDAE: Instituto para la Diversificación y el Ahorro de la Energía

PV: Photovoltaic

R&D: Research and Development

RDL: Royal Decree Law

RES: Renewable energy sources

BIBLIOGRAPHY

Akamani K., Holzmueller J.E. & Groninger J.W. (2016) Managing Wicked Environmental Problems as Complex Social-Ecological Systems: The Promise of Adaptive Governance. In Melesse A.M. & Abtew W. (Eds.), *Landscape Dynamics, Soils and Hydrological Processes in Varied Climates (*pp 741-762). Switzerland: Springer International Publishing.

Alvesson M. & Kärreman D.(2000). Varieties of discourse: On the study of organizations through discourse analysis. *In Human Relations* , 53(9), 1125- 1149. London, Thousand Oaks CA, New Delhi: Sage Publications.

Artmann M., (2015) Managing urban soil sealing in Munich and Leipzig (Germany), From a wicked problem to clumsy solutions. *Land Use Policy*, 46, 21–37.

Ayourb, N., Batres, R., & Naka, Y. (2009). An approach to wicked problems in environmental policy making. *WSEAS Transactions On Environment And Development*, 3 (5), 229-239.

Bai, X. (2007). Integrating global concerns into urban management: The scale and the readiness arguments. *Journal of Industrial Ecology*, 11(2),15–29.

Bai, X. (2003). The process and mechanism of urban environmental change: An evolutionary view. *International Journal of Environment and Pollution*, 19(5), 528-541.

Bai, X., & Imura, H. (2000). A comparative study of urban environment in East Asia: Stage model of urban environmental evolution. *International Review for Global Environmental Strategies*, 1(1), 135–158.

Balint J.P., Stewart E.R., Desai A. & Walters C.L. (2011). Wicked Environmental Problems. Managing uncertainty and conflict. Washington: Island Press

Becqué, R., Mackres, E., Layke, J., Aden, N., Liu, S., Managan, K., Graham, P. (2016) Accelerating Building Efficiency. Eight Actions for Urban Leaders. Retrieved from http://publications.wri.org/buildingefficiency/#backes.7

Biermann, F. (2010). Beyond the intergovernmental regime: recent trends in global. *Current Opinion in Environmental Sustainability*, 2,284-288.

Bulkeley, H. (2005). Reconfiguring environmental governance: Towards a politics of scales and networks. *Political Geography*, 24 (8), 875–902.

C 40 (2013). Copenhagen-Climate-Close-Up. Retrieved from: https://www.siemens.com/press/pool/de/events/2014/infrastructure-cities/2014-06-CCLA/copenhagen-climate-close-up.pdf

Cabau E. (2011) Overview of the European Buildings Regulations. Retrieved from: https://www.slideshare.net/internationalenergyagency/14-cabau

Confederation of Danish Industry (2017). About DI. Retrieved from: http://di.dk/English/AboutDI/Pages/confederation.aspx

Danish Energy Agency (2014). Denmark's National Energy Efficiency Action Plan (NEEAP). Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/2014_neeap_en_denmark.pdf

Danish Energy Agency (2015). Energy Efficiency trends and policies in Denmark. National Report for the ODYSSEE-MURE Project Planning and Studies Department. Retrieved from: http://www.odyssee-mure.eu/publications/br/energy-efficiency-trends-policies-buildings.pdf

Delarue, E., Meeus, L., & Azevedo, I. (2013). Mobilizing cities towards a low-carbon future: Tambourines, carrots and sticks. *Energy Policy*, 61, 894–900.

Directorate-General for Energy and Transport (2010) EU Energy and Transport in Figures – "Statistical Pocket Book 2010". Retrieved from: https://publications.europa.eu/en/publication-detail/-/publication/

Ecologists in Action (n.d.) About us. Retrieved from: https://www.ecologistasenaccion.org/rubrique9.html

Eduardo Torroja Institute for construction Science (n.d.) General information. Retrieved from: http://www.ietcc.csic.es/index.php/en/

Economist Intelligence Unit (2009). European Green City Index. München. Siemens AG. Retrieved from: https://www.siemens.com/entry/cc/features/greencityindex_international/all/en/pdf/gci_report_summary.pdf

Economidou, M., Atanasiu, B., Despret, C., Maio, J., Nolte, I., & Rapf, O. (2011). Europe's buildings under the microscope: A country-by-country review of the energy performance of buildings. Buildings Performance Institute Europe -BPIE. Retrieved from: http://www.zeb.no/index.php/en/reports/item/121-europe%E2%80%99s-buildings-under-the-microscope-a-country-by-country-review-of-the-energy-performance-of-buildings

EEW (2013). Country Report: Denmark - Energy Efficiency in Europe - Assessment of Energy Efficiency Action Plans and Policies in EU Member States 2013. Retrieved from: www.energy-efficiency-watch.org

European Commission (2010). Communication from the Commission EUROPE 2020 A strategy for smart, sustainable and inclusive growth. Retrieved from: http://www.buildup.eu/en/practices/publications/europe-2020-strategy-smart-sustainable-and-inclusive-growth-communication

European Environment Agency (2013). Progress on energy efficiency in Europe.

European Environment Agency (2015). Country Profile. EEA European Environment Agency. Retrieved from: https://data.un.org/CountryProfile.aspx?crName=Cuba#Summary

Eurostat (2015). Eurostat regional yearbook 2015. Retrieved from: http://ec.europa.eu/eurostat/statistical-atlas/gis/viewer/?year=2015&chapter=15

Farrel R. & Hooker C. (2013). Design, science and wicked problems. *Design Studies*, 34(6), 681-705.

Fairclough, N. (2001). *Language and Power*. Harlow: Pearson Professional Education

Foresight (2017) Foresight, Climate & Energy Business Summer / Autumn 2017. Retrieved from: https://foresightdk.com/foresight-summerautumn-2017/

Gate 21 (n.d.) About gate 21. Retrieved from: https://www.gate21.dk/about-gate-21/?lang=en

Gillingham K. & Palmer K. (2014) Bridging the Energy Efficiency Gap: Policy Insights from Economic Theory and Empirical Evidence. *Environmental Economics and Policy*, 8 (1), 18–38.

Girardet, H. (2008). *Cities people planet: Urban development and climate change.* Chichester, UK: John Wiley & Sons.

Grint, K. (2005). Problems, Problems, Problems: The social construction of 'leadership'. *Human Relations* , 58(11), 1467-1494.

Grint, K. (2008). Wicked Problems and Clumsy Solutions: the Role of Leadership. *Clinical Leader*,z I (II).

Bulkeley H. (2005). Rethinking Sustainable Cities: Multilevel Governance and the 'Urban' Politics of Climate Change. *Environmental Politics*,14(1), 42 – 63.

Head B. W., (2014) Evidence, uncertainty, and wicked problems in climate change decision making in Australia. *Environment and Planning C: Government and Policy,* 32(4) 663–679.

Haydock H. (2009). Study on energy performance of Buildings. Retrieved from: https://ec.europa.eu

Hauge A.L., Thomsen J. & Berker T. (2011). User evaluations of energy efficient buildings: Literature review and further research. *Advances in Building Energy Research*, 5(1), 109-127.

Hirts E. & Brown M. (1990) Closing the efficiency gap: barriers to the efficient use of energy. *Resources, Conservation and Recycling*, 3 (4), 267-281.

IDAE (2015). Energy Efficiency Trends and Policies in Spain. National Report for the ODYSSEE-MURE Project Planning and Studies Department. Retrieved from: http://www.odyssee-mure.eu/publications/national-reports/energy-efficiency-spain.pdf

Executive Agency for Competitiveness and Innovation (EACI) (2013), Intelligent Energy – Europe II. Performance Report 2007-2012. Retrieved from: https://ec.europa.eu/energy/sites/ener/files/2007_2012_iee_ii_performance_report.pdf

Incropera, F. (2015). *Climate Change: A Wicked Problem. Complexity and Uncertainty at the Intersection of Science, Economics,Politics, and Human Behavior.* Cambridge: Cambridge University Press.

IPCC (2007). IPCC Fourth Assessment Report, Climate Change. United Nations Intergovernmental Panel on Climate Change. Retrieved from: https://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm

Adam J.B. & Stavins R.N. (1994), The energy-efficiency gap What does it mean? *Energy Policy*, 22(10), 804-810.

La Roche P. (2009). Роль зданий в изменении климата. *Эка.ru -Журнал про экологию и архитектуру.* Retrieved from: http://www.ec-a.ru/index.php?mn=razdel&mns=61caeit35zi8e_ru . Translated by author.

Lee W.L. & Yik F.W.H (2004) Regulatory and voluntary approaches for enhancing building energy efficiency. *Progress in Energy and Combustion Science*, 30(5), 477-499.

Levine M., Zheng N., Williams C.(2012). Building Energy-Efficiency Best Practice Policies and Policy Packages. Retrieved from: https://china.lbl.gov/sites/all/files/gbpn_extended_summary.pdf

Lönngren J. & Svanström M. (2016) Systems Thinking for Dealing with Wicked Sustainability Problems: Beyond Functionalist Approaches. In W. Leal Filho & S. Nesbit (eds.), *New Developments in Engineering Education for Sustainable Development, World Sustainability Series* (151-161), Switzerland: Springer International Publishing.

Middle, G. J. (2010). Environmental policy making in highly contested contexts: the success of adaptive-collaborative approaches. *Technological Forecasting & Social Change ,*77, 924-939.

Mumby, D. (2008). Organizational Communication, Critical Approaches. In Wolfgang Donsbach (Ed.). *The International Encyclopedia of Communication,* 3427-3433. London: Blackwell.

Ney, S., & Verweij, M. (2015). Messy institutions for wicked problems: How to generate clumsy solutions? *Environment and Planning C: Government and Policy*, 33(6), 1679–1696.

ODYSSEE-MURE (2015). Energy Efficiency Country Profile Denmark. Retrieved from http://www.odyssee-mure.eu/publications/

Oñate V.G. (2017) Better House – targeting single family houses. Retrieved: http://go-refurb.eu/better-house-targeting-single-family-houses/

Owens S. & Driffill L. (2008). How to Change Attitudes and Behaviours in the Context of Energy. *Energy Policy,* 36, 4412-4418.

Pereda, P. (2015). Madrid energy efficiency in the residential sector . Integrated refurbishment : Madrid city council ' s. Futurenergy, (15), 43–46. Retrieved from www.futurenergyweb.es

Pollitt, C. (2015). Wickedness will not wait: climate change and public management research. *Public Money & Management*, 35:3, 181-186.

Ramboll Group (n.d.) About us. Retrieved from: http://www.ramboll.com/about-us

Rayner, S. (2006). Wicked Problems: Clumsy Solutions – diagnoses and prescriptions for environmental ills. ANSW Sydney: Jack Beale Memorial Lecture on Global Environment. Retrieved from: http://eureka.sbs.ox.ac.uk/93/1/Steve%20Rayner%2C%20Jack%20Beale%20Lecture%20Wicked%20Problems.pdf

Rittel, H., & Webber, M. (1973). Dilemmas in a General Theory of Planning. *Policy Sciences*, 4, 155-169.

Rio P. & Mir-Artigues P. (2014). A Cautionary Tale: Spains solar PV investment bubble. International Institute for Sustainable Development. Retrieved from: http://www.iisd.org/library/cautionary-tale-spains-solar-pv-investment-bubble

Ryghaug M. (2008). How energy efficiency fails in the building industry. *Energy Policy*, 984–991.

State of Green (n.d.) About State of Green. Retrieved from: https://stateofgreen.com/en/pages/about-state-of-green

Stavins, E. (2016). Assessing the Energy-Efficiency Gap [web blog]. Retrieved from: http://www.huffingtonpost.com/robert-stavins/assessing-the-energy-effi_b_7498296.html (accessed 5 July 2017).

Steam, S., & New, F. U. (2016). District Energy. Retrieved from: https://stateofgreen.com/en

Thomas S. (2015). Energy efficiency policies for buildings. Retrieved from: bigee.net

The City of Copenhagen (2012). CPH 2025 - a Green, Smart and Carbon Neutral City. Climate Plan. Retrieved from: https://stateofgreen.com/en/profiles/city-of-copenhagen/solutions/copenhagen-carbon-neutral-by-2025

United Nations (2009). Buildings and Climate Change, summary for decision-makers. United Nations Environment Programme. Retrieved from:

https://europa.eu/capacity4dev/unep/document/buildings-and-climate-change-summary-decision-makers

Dijk, V.D., Wouters, P., & Hogeling, J. (2008). The European Directive on Energy Performance of Buildings. The EPBD Buildings Platform. *ASHRAE Transactions*, 338-341.

Valencian Institute of Building (2011). Use of Building Typologies for of National Building Stock. Existent Experiences in Spain. Retrieved from: http://episcope.eu/fileadmin/tabula/public/docs/scientific/ES_TABULA_Report_IVE.pdf

Wei, T. (2011). Building Low-carbon Cities through Local Land Use Planning: Towards an Appropriate Urban Development Model for Sustainability. Community and Regional Planning Program Thesis. University of Nebraska - Lincoln.

Weinsziehr, T., Grossmann, K., Gröger, M., & Bruckner, T. (2016). Building retrofit in shrinking and ageing cities: a case-based investigation. *Building Research & Information,* 3218, 1–15.

PERSONAL COMMUNICATIONS (INTERVIEWS)

JACOB HØGH

Regarding EE on a Danish national level, the Danish Energy Agency is a key organization and it is based under the Ministry of Energy, Utilities and Climate. It administers Danish energy legislation and conducts analysis and assessments of development in the energy sector. The agency is responsible for handling both national and international agreements related to energy production and consumption. Jacob Høgh is a representative of Centre for Global Cooperation under Danish Energy Agency. He is an experienced Policy Advisor, expert in Energy Efficiency and Smart Grid.

Record #1

ANNETTE EGETOFT

On the Copenhagen level, Annette Egetoft, specialist-consultant, is a representative of a Copenhagen municipality working in the Climate and Energy department. She is a Project leader for *Energispring* (Energyspring) project aimed for building owners, renters and administrators.

Record #6.

STEEN OLESEN

Another government representative is Steen Olesen from Høje-Taastrup Kommune. The municipality is a part of Greater Copenhagen Area. The intention of selecting it is a success in developing and implementing local EEB projects.

Record #3

DR. CLAUDIO D. MIGUEZ

In Spain the key government body for implementing EE policies from EU is The Institute for Diversification and Saving of Energy (IDAE). It is attached to the ministry, formally as a public business body. IDAE manages energy efficiency programmes and projects to help Spain meet its 2020 energy efficiency target. As energy efficiency policies and measures are often implemented at the regional and municipal levels, IDAE also develops measures in coordination with the autonomous communities. The empirical data on IDAE is based on interview with Dr. Claudio D. Miguez who is an Industrial engineer and manager in Planning and Studies Department.

Transcript #3

DR. ARCH. ALMUDENA FUSTER

The Municipal Enterprise of Housing and Land of Madrid (Empresa Municipal de la Vivienda y Suelo -EMVS) has existed for more than 30 years. It started as an urban development department under the city council and over time became more independent. Its objectives is to manage retrofitting considering social needs. The agency works on social housing policies, research projects cofounded by EU on local and national levels with the goal to provide citizens with access to decent housing. The contribution to my research was gained by interviewing Dr. Arch. Almudena Fuster,who is a Chief of the Department of Innovation and in charge of European building energy efficiency and rehabilitation projects. Besides, Almudena is an associate professor at the University of Alcala de Henares.

Record #1

KRISTIAN HENNINGSEN

In Denmark, the Confederation of Danish Industry (DI) is a private organization funded, owned and managed by 10,000 companies within manufacturing, trade and service industry. Their mission is to provide the best conditions for businesses through policy advocacy, services for member organizations in information, consultancy and networking (Confederation of Danish Industry, 2017). The representative Kristian Henningsen is a chief consultant who has previously worked at Danish energy Agency in construction sector. Currently he is involved in doing lobbies for DI.

Record #7

ANDERS DYRELUND

Ramboll one of the leading engineering, design and consultancy in Denmark. It was founded in 1945 and currently employs over 13,000 experts and has offices worldwide. The company works across the sectors of buildings, transport, urban planning, water, energy, oil and gas (Ramboll Group, n.d.). Anders Dyrelund was interviewed as he is a senior market manager in energy planning and production.

Record #9

DAN HOWIS LAURITSEN

State of Green is the official green brand for Denmark. It is a public-private partnership founded by the Danish Government, the Confederation of Danish Industry, the Danish Energy Association, the Danish Agriculture & Food Council and the Danish Wind Industry Association. Their mission is to gather leading Danish actors in field of energy and environment and promote the best solutions abroad (State of Green, n.d.). To gather empirical data I was pleased to interview Dan Ho Howis Lauritsen - Head of Communication of State of Green.

Record #8

JESÚS ROMÁN

In Madrid, the Architectural Firm Rafael de la Hoz Arquitectos is one of the leading companies in terms of sustainable and high-performance design. Dated since 1920 it has enabled the successful completion of more than 500 projects in 20 different countries. Among their most outstanding projects with highest certifications as LEEDS or BREAM are the new Repsol headquarters in Madrid and the headquarters of the Telefónica company. It was my pleasure to interview Jesús Román who is a project manager for many leading projects.

Record #12

INÉS LEAL

Consulting Group Grupo Tecma Red is the first and biggest media and communication company in sustainability and constructions in Spain. Their mission is to inform and generate knowledge about energy sustainability and technologies in building sector. They provide with five internet portals about intelligent buildings, sustainable construction, energy efficiency, smart city and smart grid. Every year congresses dedicated to these topics are being conducted. I had a chance to interview Inés Leal. She is an Editorial Director and responsible for the contents of the portals and events.

Record #16

JESPER OLE JENSEN

The Danish Building Research Institute (SBi) is the national building research institute and affiliated with Aalborg University. It is aimed at developing research-based knowledge to improve buildings and the built environment. To contribute to the thesis I have interviewed two experts from SBi. Jesper Ole Jensen is a Senior Researcher at Department of Town, Housing and Property. He has engineering and planner background. For last 6 years working with SBi in relation to urban ecology and EEB. He mostly interested in organization and management of encouraging different actors to promote EE.

Record #4

OLE MICHAEL JENSEN

Another expert is Ole Michael Jensen, Senior Researcher at the Department of Energy Performance, Indoor Environment and Sustainability of Buildings. Originally, he is an urban planner. For many years, he worked with human behavior and incentives to tackle it, while his main interest lies in essence of preferences in lifestyle in city versus outside. Lately Ole works with energy supply.

Record #5

KARL SPERLING

Another representative from a research institution is Karl Sperling. He is an associate professor of Aalborg University in Faculty of IT and Design in Department of Planning. The field of the Department of Planning includes development and planning in both social and physical planning, as well as technical and engineering aspects of development and planning. Karl has a background in Environmental planning, and now works in sphere of Danish cities and municipalities energy planning.

Transcript #1

BEATRIZ ARRANZ

In Spain, the Institute of Construction Sciences Eduardo Torroja (IETcc) is an important scientific center in the area of science and technology, construction and materials. It collaborates in the development of the Technical Code of Construction, mandatory regulations, providing permanent technical support to the Ministry of Development (Eduardo Torroja Institute for construction Science, n.d.). Beatriz Arranz is a representative of the Institute. She is a researcher in the area of EE through glazing, interior environment efficiency, and performance of the facades (daylighting simulations).

Transcript #2

FELIX AVIA ARANDA

The CIEMAT (Center for Energy, Environmental and Technological Research) is a Public Research Institution attached to the Ministry of Economy, Industry and Competitiveness with focus mainly in the fields of energy and Environment. CIEMAT carries out R & D projects in the area of energy, works on study, development, promotion and optimization of the different sources of energy, the technologies and their impact on the environment. Felix Avia Aranda, is an expert in renewable energy, works in CIEMAT since 1986 and currently the President of the European Academy of Wind Energy (EAWE) and the Operator Agent of the Task 11 “Base Technology Information Exchange” of the Wind implement agreement of the International Energy Agency.

Record #17

TOMMY OLSEN

In Denmark, the non-governmental organization Gate 21 is based on a partnership between municipalities, companies and knowledge institutions, with the aim of accelerating the green transition. It has operated for six years, working within Greater Copenhagen. The strategy is based on using regional and local demand to develop, demonstrate and deploy new energy and resource-efficient solutions (Gate 21, n.d.). Tommy Olsen works as a Consultant part time at Gate 21 and part time at place called Energy service. He sees his role in helping municipalities to make people renovate, with focus on single-family houses.

Record #2

MR. RODRIGO IRURZUN

In Spain, non-governmental organization Ecologistas en Acción is one of the five biggest environmental organizations in country. It is part of social ecology, which reckon that environmental problems have their origin in an increasingly globalized production and consumption model. Therefore, it finds its mission in raising public awareness campaigns, legal denunciations against actions that damage the environment, by producing concrete and viable alternatives (Ecologists in Action, n.d.). For the research, I have interviewed Mr. Rodrigo Irurzun, who is a civil engineer and works as a volunteer in a climate change area. At the NGO, he is responsible for the Energy Division sector. Besides that, he works as a technician in renewables for the energy efficiency of the buildings in the ECCO.

Record #14

INTERVIEW TRANSCRIPTS SUMMARY

TRANSCRIPT #1

Main barrier in implementing EEB

The biggest issue is retrofitting and as energy is cheap today, you won't have incentives to retrofit –not much benefit. In Aalborg university we did the project and proposed the scheme of reduced energy pricing that reflects the system. Prices on energy in DK depends on each owner – municipality or private company. The owner regulates the price by board. However, the is a low in DK that those organizations should not make extra profit. Profit should be paid back to consumer. For consumer there are actually 2 parts of the costs: Variable part and extra part. The variable part reflects your consumption, while fixed part you pay to maintain the system whether you use en4ergy or not. Therefore, even if u save energy, you save just share from one part, and pay full fixed, so in the end saving is not much, not full credit. Need to force politians make full variable cost, to make it more flexible and attractive to costumer. I assume that economy in CPH is an issue, due to the complexity of different energy systems and their pricing structures.

1. Problem of communication

As a homeowner if u not interested in EE, being a regular consumer but forced to think about EE then in Denmark its overwhelming. The information to homeowner should be conducted simple and easy, maybe from through personal contact. Municipality and energy companies need to have better strategies and invest more into better marketing and communication. For regular consumers easy access and personal contact could be crucial. Especially if you do a deep renovation, and your house is being remodeled, it affects your everyday life, you need skillful trustworthy workers. Ideally, the initiatives should come from the actors, whom citizens trust. For example, the public institutions, or neighbors who had experienced it already. Sociology is very important when it comes in triggering people. Subsidies and guarantees might play a good role here.

2. Financial

I see a big barrier in economy side. Although, there is a share of population who does not have an access to finance, most of the people have an access to the finance to invest. The problem is, that many of the is not aware. However, it is a big investment and big decision, and unfortunately for most of the people it doesn't appear as an attractive step. I would call this barrier is physiological economic barrier, describing not the lack of money, but scare/ preconception/opinion on losing a big amount. People has different priorities for their money, with more tangible benefits. For them EE does not appear as necessity and they not ready to sacrifice being locked at the place/house for few years waiting for the payback time.

3. Technology risk

New building are not a problem due to the strict regulations and small share of new constructions in general.

Nevertheless, I found regulations too tight. For example, NZB requirements as to add solar panels which are extremely ineffective in Danish case. Economy of scale simply describes the situation and potential benefits. Sometimes there is a very thin line between renovation

and new construction. For example if you replace walls, windows and roof with new materials it will be newly constructed building called renovated.

4. Skills gap

Regarding modern architects and engineers, personally, I see the issue in not putting enough effort in building commissioning. It is very important to include in total costs parameter of maintenance, operation costs of the building as well as the clear lifecycle frame. For example, it is a clear requirement for that in special certification as DTNB.

TRANSCRIPT #2

1. Biggest problem is awareness
   The biggest issue in Spain that people are not aware. Devices work well but people do not know. The general idea : if they aware concept that efficient buildings cost more, people don't want to spend moreover after crisis, this sector badly placed right now, hardly prioritize.
   From the other hand, it is a big opportunity after the crisis being in a bad place to start a different way, now we have to achieve 202020 objectives
   From one way the not aware and from another they do not have technical information either. Therefore, they lack the knowledge. The agents of the sector lack knowledge too. It is all about money. For example, how long will take the investment to payback for energy refurbishment/.
2. Marketing
   People do not care to spend 800 euro for an iPad, but for a window, it's too much. How to change it? Regulations, actions to make people know. In Spain, the renovation should be mandatory. Because we do not have in culture to take care of the building from outside. Moreover, it's not just crisis, It is the lack of priority.
3. Certifications
   Most of the buildings were build long ago already. At 2006 regulations were ready but crisis hit.
   So for those hard to get AA certificate. New building just accomplish the limits. I do not think that builders try to get AA. Only if its big company, for marketing purpose to build green building. Probably just hard to prioritize: if you can pay less and get certificate D and get along with this.
4. Energy poverty.
   When we do the simulations and calculations we always think that there is energy demand in the building, so people are in the comfort levels and they consume energy, but in reality its not always like this. There is an energy poverty and people don't live in the comfort level and they won't use energy even if they retrofit. Theoretically, you can get investment in insulations façade and you will get your money back because they will save money on heating. But if you don't use heating because you don't have money, then you won't get the money back.
5. Bigger problem - social economic.
   Government should take into account social level. Direct aids. Spain buys energy outside, so if we consume less then its more beneficial.
6. Financial schemes.

Mechanism should work between government-banks-users . Maybe start with vulnerable neighborhoods and success will see it and copy it. Banks should give the loans to retrofit. But its hard here because all the building must agree. Therefore - Property law. Its needs to be changed so banks able to finance.

7. What about EPBD?
   Everyone can buy certificates, corrupted, cheap, it does not work.
   People do it because it's mandatory if you need to buy house or rent. Take the information, change it no one cares, only because its mandatory.
8. Problems in education
   Regarding new buildings should be easier but global problem here not included in education system enough- current architects didn't have environmental concerns when studied.
9. NZB
   Its cannot be defined, its not he same as here or in Russia – architect must take into account the place. And constructors should think of technology. if the paradigm will change. In Spain, it could be easy, because we can use renewable cause climate not that bad. For heating water solar panels for residential and public buildings here. Solar in residential mandatory for water.
10. Solar panels.
    Technical problems. They were integrated installed but they were not so many technicians prepared. So some were not build very well and now there is a bad reputation.
11. Actors
    Fragmented: governments, market, all the construction, users. Lack of coordination.
    Need to share responsibility : obligations and benefits. Doubt that users can solve the problem. Between all of us wee can do it.

TRANSCRIPT #3

As expected, expert was not willing to talk about problems. Problems for him are technical: building envelope, and insulations.
However, he introduced closer the National Plan.
National plan NEEAP:

- 200 million budget for 2016 (12 years, FEDER)
- NEW Actions for coming year
- PAREER – CRECE retrofitting , improving letters in certification
- Marketing campaigns (TV, Radio, internet, newspaper) about renewables, efficient mobility, etc.

Separate plans for each autonomous community:

1. Certification works, but during crisis low-quality certify. Due to the fact that fake companies run business.
2. Problem is control the process, no one to check final project, whether everything from proposal was established.
3. Old buildings biggest issue, because they are not obliged to take any actions.
4. 2020 plan seems possible.
5. Perhaps EPBD is too optimistic and will not be fulfilled correctly.

PHOTO CREDITS

All images of cities are taken from the Web, from the official publicly open websites with photos of the different destinations:

- http://freelargephotos.com/
- https://pixabay.com/
- https://www.skyfish.com/p/copenhagenmediacenter
- https://unsplash.com/

References for the figures and tables could be found in bibliography. Figures and tables with no reference are created by the author.

Most of the photos of experts were taken by the author, some of the pictures are taken from official LinkedIn page of each person.