

A FRAMEWORK FOR POLICY MIX ANALYSIS: PORTUGUESE CASE STUDY ON ENERGY POVERTY

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**Dissertation submitted for partial fulfilment of the requirements for the degree of
MASTER IN CIVIL ENGINEERING — SPECIALIZATION IN PLANNING**

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JULY 2021

MESTRADO INTEGRADO EM ENGENHARIA CIVIL 2020/2021

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Aos Meus.

*É um cansaço que ambiciona, não o deixar de existir- o que pode ser ou pode não ser possível-
,mas uma coisa muito mais honrosa e profunda, o deixar de sequer ter existido, o que não há
maneira de poder ser.*

Bernardo Soares

ACKNOWLEDGMENTS

To all the Portuguese people who helped me during my education and development of this thesis, I will thank them individually in our native language.

Gostaria de começar por agradecer aos meus orientadores, Professora Isabel e Professor Paulo, por me terem ajudado a desencalhar quando o tema parecia impossível e me terem dado as ferramentas para me tornar uma melhor Engenheira. Agradeço ainda todo o tempo que disponibilizaram e o apoio que me deram para confiar mais nas minhas capacidades e revelar o meu melhor trabalho.

Agradeço aos Engenheiros Rui Pimenta e Pedro Pombeiro por me terem fornecido informação para a contextualização dos temas abordados e realização desta dissertação.

Aos meus pais, agradeço a oportunidade que me deram em realizar este percurso académico e por terem sido flexíveis às minhas incertezas no meu futuro. À minha irmã, Sílvia, agradeço por ter sido sempre o meu exemplo a seguir e por ter-me mostrado novas janelas para ver mais e acreditar mais em mim. Obrigada especialmente por todo o apoio e compreensão que me deste neste percurso que só tu podias dar, desde algo mais pragmático até ao mais holístico do nosso ser. Ao meu cunhado, Nuno, agradeço por ter estado presente para me ajudar e por me lembrar que o melhor está para vir.

Sem momentos de diversão e de descompressão não é possível concretizar as épocas mais cansativas da nossa vida. Por isso, agradeço aos meus amigos que me acompanharam na minha vida escolar e académica que me permitiram os bons momentos que geraram a energia para continuar a luta. Em particular, agradeço à Rita e ao Parracho, por serem não só os meus colegas insubstituíveis nas realizações de todas as tarefas complicadas a que a FEUP nos testou, mas, também, em tornarem-se os amigos que levo desta vida desgovernada. Rita, agradeço-te especialmente por seres o yin do meu yang mas que sempre reconhece as dificuldades que ambas passamos quando é preciso.

Aos meus *puppies bogalhudos*, agradeço-vos todo o carinho que me deram quando eu mais precisava. A vossa natureza pura trazia a calma e alegria nos dias que mais precisava. Obrigada por me mostrarem que não estava bem quando nem eu própria sabia através da vossa atenção minuciosa.

Ao meu namorado, Tiago, agradeço todos os momentos. És a pessoa que mais acredita em mim, que me compreende por inteiro e que viu o background completo desta luta. Obrigada por me aturares nos dias maus, por celebrares comigo as pequenas e grandes vitórias e por seres a minha fonte de segurança sempre que duvido, e duvidei, de mim. Agradeço ainda por aturares os meus horários desalinhados, os meus esquecimentos diários e o cansaço que, de alguma forma, expressei da forma mais agitada possível. Não teria conseguido isto sem o teu apoio e suporte.

ABSTRACT

Under the topic of sustainable transitions and climate change mitigation, different policies are being developed, at different policy levels. Paris Agreement, Clean Energy for all Europeans Package, UN Sustainable Development Goals and Renovation Wave are examples of how a path is being developed to define and achieve climate target goals. In this context, different countries and local entities are also contributing to change how different policies can be articulated to achieve these goals.

Energy Poverty is an example of a current problematic that requires a complex mix of policies for its combat. Income, Energy Prices and Buildings/Energy Efficiency are the main recognised factors with consequences on the health and well-being of the energy poor. However, Energy Poverty is not only related to the income and social policies, but energy and building policies need to interact with each other to fight Energy Poverty. Therefore, Policy Mix must be considered to Energy Poverty Mitigation.

A framework for Policy Mix analysis is proposed, based on the theoretical background surveying the state of the art on Policy Mix and Policy Coherence. This flexible, iterative, and systemic process is tested on a Portuguese case study on Energy Poverty, showing promising results to how the framework can be used, not only for Energy Poverty topic, but also the general policy fields being covered under the current policy debate on sustainable transition. Coherence is especially used as a criteria to evaluate the instruments interactions and the policy strategy of the case study.

The case study considers 10 instruments covering the European, national and local levels. The Single Instrument Analysis step proposed by the framework collects how each instrument is contributing to the Energy Poverty fight. In this way, a reference point is generated which can be used to monitor, manage, and compare in further research. The Instruments Interaction Analysis and Evaluation steps, on the other hand, permit to visualize how a coherent policy strategy is being developed in the Portuguese context, covering the three factors of Energy Poverty previously mentioned.

In conclusion, a framework for Policy Mix analysis is proposed considering three different concepts that integrate the current discourse on sustainable transitions and climate change. The case study shows how the framework can identify the interactions and evaluate the policy strategy. In addition, the results also reinforce that the framework can and should be used to cover other policy fields and different topics. Moreover, final recommendations to the instruments assessed and the further research on Policy Mix analysis are considered.

KEYWORDS: Policy Mix; Coherence; Energy Poverty; Framework for Analysis; Interaction.

RESUMO

Atualmente, diferentes políticas estão a ser desenvolvidas, a diferentes níveis, para a mitigação das alterações climáticas e transições sustentáveis. O Acordo de Paris, O Pacote Energia Limpa para todos os Europeus, os Objetivos de Desenvolvimento Sustentável da ONU e a *Renovation Wave* são exemplos de como está a ser desenvolvido um trajeto para a definição e alcance das metas climática. Sendo assim, diferentes países e entidades locais estão a contribuir para este tema através da articulação de diferentes políticas.

A Pobreza Energética é um exemplo de um problema que requer a combinação de políticas complexas para a sua mitigação. O rendimento, o preço da energia e a eficiência energética/ das habitações são os principais fatores que trazem consequências para a saúde e o bem-estar das pessoas mais vulneráveis à Pobreza Energética. No entanto, a Pobreza Energética não está apenas relacionada com o rendimento e as políticas sociais mas, também, as políticas de energia e habitacionais precisam de interagir umas com as outras para combater esta problemática. Desta forma, o conceito *Policy Mix* deve ser considerado para a mitigação da Pobreza Energética.

Uma nova metodologia de análise das *Policy Mix* é proposta tendo em conta o estado da arte sobre o *Policy Mix* e Coerência de Políticas. Esta metodologia engloba um processo flexível, iterativo e sistémico que é testado num estudo de caso português sobre Pobreza Energética. Os resultados do estudo de caso permitem mostrar como esta nova metodologia pode ser utilizada não só para o tema Pobreza Energética mas, também, para diferentes tópicos que estão a ser abrangidos no debate político sobre a transição sustentável. A coerência é especialmente usada como um critério para avaliar as interações dos instrumentos e a estratégia política abordada no estudo de caso.

O estudo de caso considera 10 instrumentos que abrangem os níveis europeu, nacional e local. A etapa proposta da *Análise de Instrumento Individual* analisa como cada instrumento contribuiu para o combate da Pobreza Energética. Desta forma, um ponto de referência é obtido e pode ser utilizado no futuro para monitorizar, gerir e comparar. Por outro lado, as etapas *Análise de Interações dos Instrumentos* e a *Avaliação* permitem visualizar como está a ser desenvolvida uma estratégia coerente no contexto português para a mitigação da Pobreza Energética.

Em conclusão, a metodologia proposta para análise de *Policy Mix* considera três conceitos diferentes que integram o discurso atual sobre as transições sustentáveis e alterações climáticas. O estudo de caso mostra como a metodologia permite identificar as interações entre instrumentos e avaliar a estratégia política. Além disso, os resultados também reforçam que esta metodologia pode e deve ser usada para diferentes temas estudados na *Policy Mix*. São ainda apresentadas recomendações finais para os instrumentos analisados e sugestões para aplicações futuras da metodologia desenvolvida.

PALAVRAS-CHAVE: Policy Mix; Coerência; Pobreza Energética; Metodologia de Análise; Interações.

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SYMBOLS, ACRONYMS AND ABBREVIATIONS

- **ADENE**- Agência para a Energia / Energy Agency
- **CEP**- Clean Energy for All European Package
- **COST**- European Cooperation in Science and Technology
- **DGEG**- Portuguese Directorate-General for Energy and Geology
- **EEF** - The Energy Efficiency Fund
- **EF** - Environmental Fund
- **ELPCPE**- Estratégia Nacional de Longo Prazo para o Combate à Pobreza Energética 2021-2050 / National Long-Term Strategy to Fight Energy Poverty
- **ELPRE**- Estratégia de Longo Prazo para a Renovação de Edifícios / National Long-Term Strategy for Buildings Renovation
- **EMS** -European Union Member States
- **EP**- Energy Poverty
- **EPOV**- Energy Poverty Observatory
- **EPVI** – Energy Poverty Vulnerability Index
- **ERSE** – Portuguese Energy Services Regulatory Authority
- **EU**- European Union
- **FAI** - Fundo de Apoio à Inovação / Innovation Support Fund
- **FEUP** – Faculdade de Engenharia da Universidade do Porto
- **GRA** - Regional Government of the Azores
- **GRM** - Regional Government of Madeira
- **HPP**- Harzing’s Publish or Perish
- **IFRRU**- Instrumento Financeiro Reabilitação e Revitalização Urbana
- **MAAC** - Portuguese Ministry of the Environment and Climate Change
- **METD** - Portuguese Ministry of the Economy and Digital Transition
- **MIH** – Portuguese Ministry of Infrastructure and Housing
- **MTSSS** - Ministry of Labour, Solidarity and Social Security
- **OECD**- Organisation for Economic Co-operation and Development
- **PCSD**- Policy Coherence for Sustainable Development
- **PEES**- Programa de Estabilização Económica e Social
- **PNAEE**- Plano Nacional de Ação para a Eficiência Energética
- **PNEC**- Plano Nacional de Energia e Clima / National Energy and Climate Plans
- **R&D** – Research and Development
- **RNAE** - Associação das Agências de Energia e Ambiente / Association of Energy and Environment Agencies
- **RNC 2050**- Roteiro para a Neutralidade Carbónica 2050 / Roadmap for Carbon Neutrality 2050
- **SDG**- Sustainable Development Goals
- **UN**- United Nations

1

INTRODUCTION

1.1. FRAMEWORK AND JUSTIFICATION

There is a current discourse around the mix in different questions of policies, not only by institutions (EU and OECD) but also by scientific literature and national context of different countries. The discourse is focused on sustainable transitions and climate change and mitigation. For instance in the Paris Agreement or the Sustainable Development Goals (SDG's), Energy Poverty takes a special place in the context of EU recent policies (Bouzarovski & Thomson, 2020; Moure et al., 2021; Paris Agreement, 2015).

United Nations (UN) defines 17 SDG's (figure 1), adopted in 2015, as *“a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030”* and notes how these interact and require the integration of each other (United Nations, 2017).

Energy Poverty is an example of the integration of SDG's. Different dimensions of the problem interact within themselves, ending up affecting outcomes of each other. The problematic combines the lack of income, energy prices, energy access and efficiency of housing or technologies used, and has consequences to the health and well-being of the targeted population. Moreover, women are the most vulnerable demographic group in this problem (EPOV, 2019, 2021b; Gouveia et al., 2019; Gouveia & Palma, 2021c). Therefore, fighting for no poverty (SDG 1), good health and well-being (SDG3), gender equality (SDG 5), affordable and clean energy (SDG 7) and reduced inequalities (SDG 10) are examples of SDG's that Energy Poverty interacts with.



Figure 1 Sustainable Development Goals. Source: (United Nations, 2017)

Based on the interactions of different dimensions, goals and field, the complexity of the Energy Poverty issue requires the combination of different policies and their respective blocks. In addition, Energy Poverty is an issue which has been gaining more relevance in the last years because of its relationship with energy policies and, consequently, its intrinsic connection with sustainable transitions and climate change mitigation (Gouveia et al., 2019; Primc & Slabe-Erker, 2020; Sareen et al., 2019).

Furthermore, Policy Mix and Policy Coherence are being considered in the current debate of climate change and its mitigation and the sustainable transitions prevalently mentioned by OECD and European Union (Chan et al., 2021; Moure et al., 2021; Recuero Virto, 2018; Rogge & Reichardt, 2016). There is not yet a universal definition or a framework for analysis of Policy Mix. Moreover, Policy Coherence relation with the sustainable developments and policy analysis shows a possibility to connect the three concepts and construct a clearer vision of their interaction.

In this context, Policy Mix, Policy Coherence and Energy Poverty will be addressed considering their different blocks, definitions and methods for analysis. A framework for Policy Mix analysis will be proposed and tested in the Portuguese case study on Energy Poverty.

1.2. METHODOLOGY AND OBJECTIVES

After presenting a theoretical background, which reviews the present knowledge about the three main topics (Policy Mix, Policy Coherence and Energy Poverty), a framework proposal for Policy Mix analysis will be presented. The aim is to develop a framework which can be used in different policy fields under different topics to understand the Policy Mix by evaluating the instruments individually and visualize their interactions. In this way, a clear process will help to structure a systematic and

iterative method that combines the Policy Mix blocks and the Policy Coherence studies to comprehend the complex issues that are currently being contemplated at the different levels of the policy studies.

The case study on Energy Poverty will test this framework showing not only the advantages of its use but also contributing to the topic itself. Different and recent instruments were selected and analysed to comprehend the existent Policy Mix in Portugal and in the European Union, too. The survey of information realized on the context of the Energy Poverty, at the European and nation level, also aims to draw the current point of the Energy Poverty before the instruments contribute to its Indicators. In this way, the collected information can also be used as reference point of comparison in the future monitorisation, management or research.

1.3. STRUCTURE OF THE THESIS

This dissertation is organised in five major chapters constructing a flow structure to understand the different topics here addressed.

Chapter 2 provides a theoretical background that contemplates three different concepts: Policy Mix, Policy Coherence and Energy Poverty. The limits of each concept are established, and their relations are concluded in the synthesis.

Chapter 3 proposes a framework for Policy Mix analysis. The different steps are explained and supported by the literature used. Then, a synthesis bridges the different steps and overviews the framework.

Chapter 4 applies the proposed framework to a Portuguese case study on Energy Poverty. The Portuguese context of Energy Poverty is presented, to define how the different steps of the framework should proceed. Then, the results are presented and organised for the instrument analysis and evaluation steps of the framework. Lastly, the synthesis overviews the application of the framework and the results obtained.

Chapter 5 finalizes the document with discussion and conclusions. The relation of the three different topics is explained and the results obtained from the Portuguese case study on Energy Poverty are used to justify the relevance of the proposed framework. Finally, recommendations to further research are presented.

2

THEORETICAL BACKGROUND

2.1. FRAMEWORK FOR LITERATURE SELECTION

The Framework for Literature Selection, and subsequent review, aims to, in a systemic and iterative way, find the most recent and peer-reviewed literature which can support the definition of theoretical concepts in a more complete way. Currently, the access to information and different search mechanism are abundantly offered and a methodology for selection and definition of criteria to select this information was crucial.

Therefore, an approach was developed that combines the freedom of brainstorming as the first steps to guide and define unbiased lines of actions and then, a Systematic approach was adapted which combines the capabilities of bibliometric literature analysis of the literature for a more efficient and productive way of selecting literature. Figure 2 summaries the overview of the orientations adopted in the Literature Analysis Framework, highlighting the key topics of each other.

Starting by the **Brainstorm and Free Search** on published literature on different search engines, different keywords were used to understand the concept of “articulation” and “instruments”. This was achieved by a try and error application and combination of different keywords such as articulation, coherence, urban policies, sustainable transitions and integration to brainstorm the different possible approaches this dissertation could take.

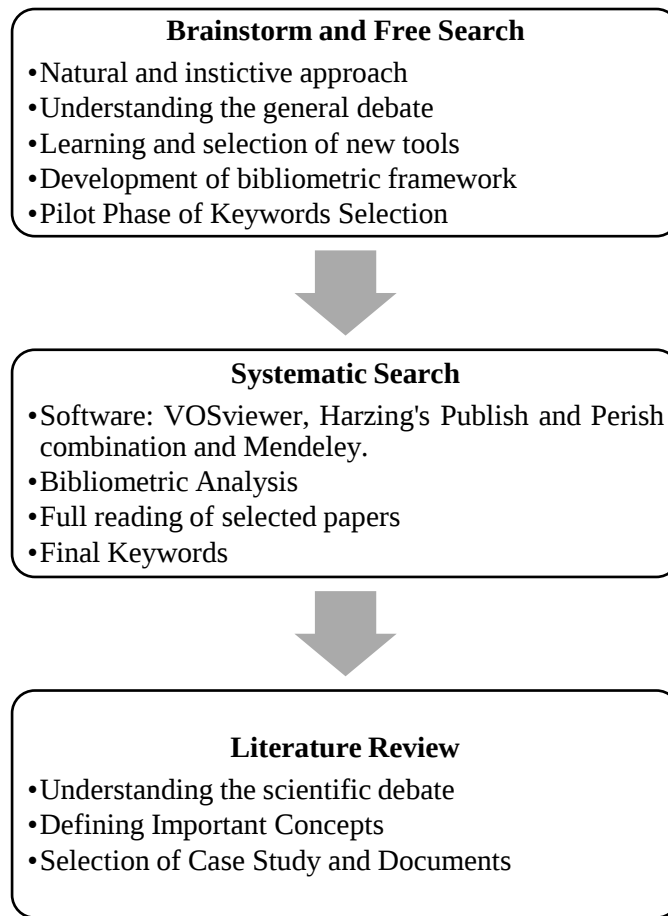


Figure 2 Literature Analysis Framework and Objectives

In this step, different search tools were already used to identify different scientific papers. However, other sources were also considered to establish an unbiased and more holistic search of information. Official videos of OECD and other governmental institutions were watched to understand the current public debate and identify other tools and source of information. In consequence, bibliometrics analysis and different software were identified to their application on the next step of the framework. It was also followed the different national and international journals to keep up with the changes occurring at the International and National level which helped identifying the emergent debate on Energy Poverty, the development of the long term strategies and the European Climate Law proposal (Agência Lusa, 2021; Frédéric Simon, 2021; Ribeiro, 2021). This step is summarised on table 1 and a more detailed explanation of the framework steps is presented on Annex 1.

Table 1 Brainstorm and free search step summary

Brainstorm and Free Search	
Goal	• Combining creativity with the creation of framework to analyse literature. • Freedom of the search. • Brainstorming. • Finding the connections, patterns, and more important keywords in an iterative and instinctive manner.
Tools	Microsoft Academic, Google Scholar, Scopus and Science Direct.
Results	• Important keywords: Policy Mix, Climate Mitigation and Coherence • Software to use next: VOS Viewer, Harzing's Publish or Perish and Mendeley
Instruments used	• Excel: organising the information collected in different subtopics. • Diary Notebook: mind mapping, draft, free diagrams, time management and visualization of the process.

Furthermore, since politics and their respective process happen daily, creativity was an important part of this step to adapt and understand what was already published, will be published, and was not discussed. Consequently, the process of selection of literature was not directional but iterative.

At this point, the **Systematic Search** was developed in a way to use the existent knowledge and develop an interesting and innovative framework to recent topics or new ones. This step consider the present development of studies assessing bibliometric analysis for literature selection (Goyal & Howlett, 2019; Guleria & Kaur, 2021; Nobanee et al., 2021).

Moreover, this step integrates the information tools provided by the technology existent in combination with the bibliometric analysis. The software used was selected in a try and error experiment until the fulfilment of the expectations. With a more structured and backboneed process, it was possible to find keywords, authors, connections and the most recent topics more productively. This combination led to better define an innovative and peer discussed theme and it is represented by a flowchart in figure 3.

Software was an important tool to manage time, quantity and quality of literature which could be use to this thesis. Harzing's Publish and Perish (HPP) is a software program which integrates different search engines in a way to find more literature more rapidly though an analyzation of academic citations and different metrics(Harzing, 2021). In combination with the VOSviewer, it was possible to visualize the authors and their keywords. This iterative process between each software was an important step to delimit the theme of this thesis and selection of the case study. The framework for literature selection was essential to understand the interconnections of the different concepts and to test if the case study considered integrated the present policy debate and scientific literature.

The maps of keywords and authors created with VOSviewer suggested that Policy Mix was currently being discussed in climate change and mitigation in OECD and European Union (Annex 2).

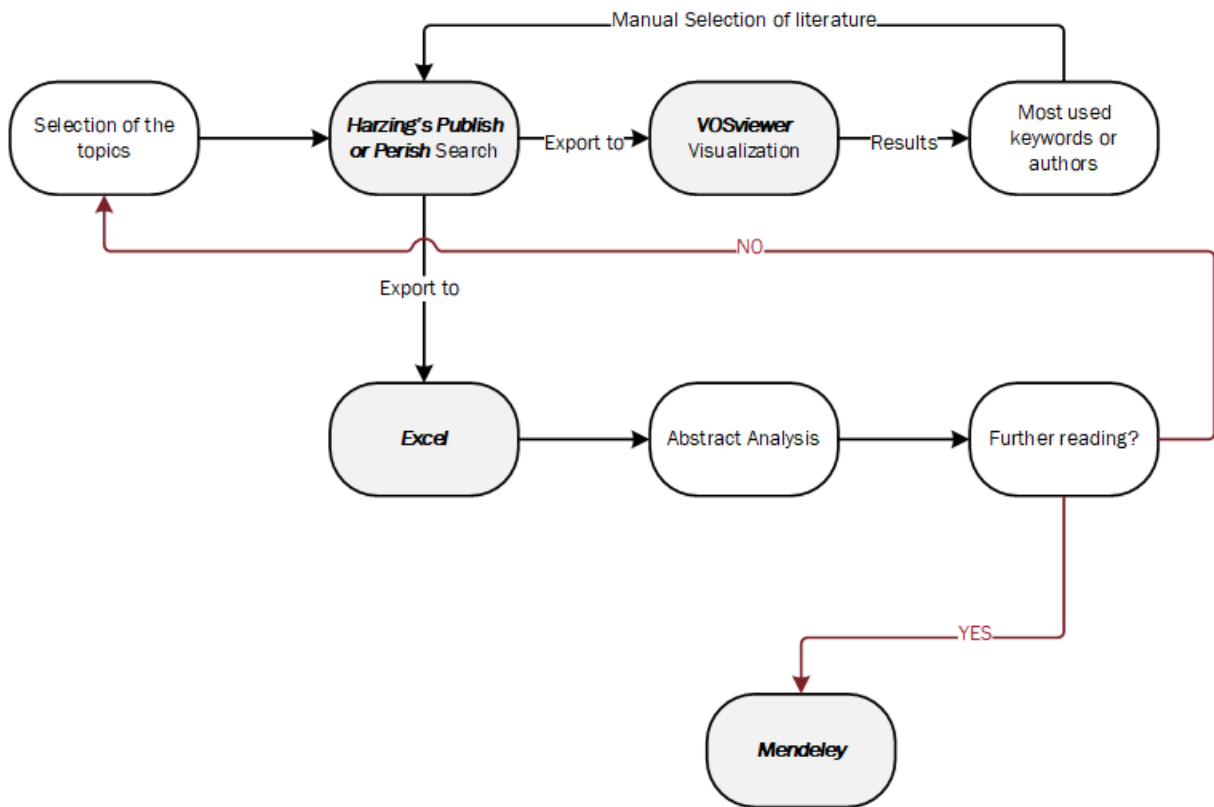


Figure 3 Systematic Literature Search Framework

In summary, the methodology of this work started by the literature selection, analysis and its revision. This was achieved by an iterative process which considered the evolution of two types of literature search: Brainstorm and free search and Systematic search. The former has in goal the generation of a more natural and free understanding of tools and publications. In this part of the process, it was possible to draw, use different type of information and learn new tools to further apply in the process in a way which was pressure free when it comes to the stratify references, define limits and unbiased observation of the information offered. This was accompanied with the register on a diary notebook and an Excel organisation subtopic in a way to document the process and its further use to better understand the development of the work. The latter made possible to better use the current information tools provided by the technology existent and to find keywords, authors, connections, and the most recent topics more productively.

It is also important to note that the manual selection of literature occurred at the same time of the network visualization. Excel was used to read the abstract of the literature searched in the HPP, which

could be more than 100 scientific papers and books, and then, in case some paper stood out from other, Mendeley was used to further reading, notes and backup of literature.

2.2. CONCEPTS PRESENTATION AND JUSTIFICATION

The literature selection was essential to identify the connections of different concepts. The development of the literature analysis converged in three different concepts which will be covered in the theoretical background: (1) Policy Mix, (2) Policy Coherence and (3) Energy Poverty. The latter was integrated in Energy policies debate which integrates the sustainable transitions and complex issue. This will be the essential link between the three concept and will be explained under its respective segments.



Figure 4 Concepts covered in Theoretical Background

At first sight, a major question may appear: *why will Policy Mix and Policy Coherence be addressed separately?* The reason for this approach is related to the studies being developed under the Policy Coherence theme (Breuer et al., 2019; Chan et al., 2021; Mickwitz et al., 2009; OECD, 2021c; Recuero Virto, 2018). As can be observed in figure 5, Policy Coherence is specially related to climate literature and the recent policies for sustainable transition. Three different groups are observed. First, in blue, Policy Coherence is related to the policy design, complex problems, and fragmented government actions, Second, in green, climate goals, climate change and sustainable transitions are identified. Lastly, in red, policy integration, policy analysis and impact assessment appear as the Keywords connected to Policy Coherence literature.

In addition to the overview of Policy Coherence related keywords in figure 4, the reading of the abstracts and some initial papers helped to clarify the line limiting the themes covered by Policy Coherence and Policy mix. The first impressions under the Policy Coherence topic permitted to observe that Agenda 2030 (United Nations, 2017) and the future policies being discussed across different levels of government for climate change and its mitigation were the focus of the Policy Coherence literature. Moreover, sustainable transitions were being specially discussed on OECD publications in combination with Policy Coherence and Instrument Mixes- figure 4 (Diercks, 2019; OECD, 2007, 2012, 2016, 2018b, 2019, 2021c).

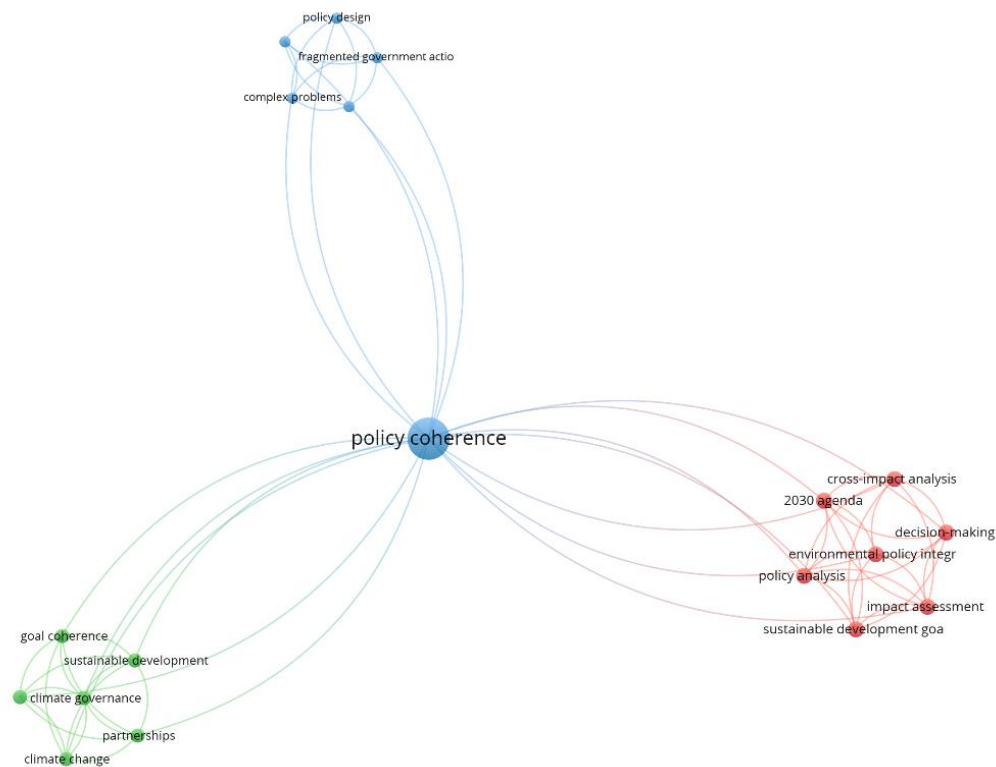


Figure 5 Keywords Network visualization of Literature Selected under the Policy Coherence topic

Although Policy Coherence does not directly mention Policy Mix in its studies, this concept was the ignition factor to understand how Energy Poverty and Policy Mix could be applied together to develop an integrated study of the three concepts. Bearing this in mind, the Policy Coherence segment will focus on distinguishing different topics being covered in Policy Mix and Energy Poverty and present its blocks so a relation to Policy Mix will be recognised.

As it will be further explained, Policy Mix literature focus on defining the concept itself and developing experimental methods for its evaluation. Figure 6 shows how coherence, in red, and policy evaluation, in green, are different groups of keywords interconnected with Policy Mix. In this way, it is possible to understand that Policy Coherence literature will focus on developing the analysis of policy instruments to sustainable transition and the achievement of the coherence goals. On the other hand, Policy Mix studies focus on understanding how the policies are organised in their mix and defining the concept to further analysis. This relation was also observed in the abstract reading and the complete reading of the literature.

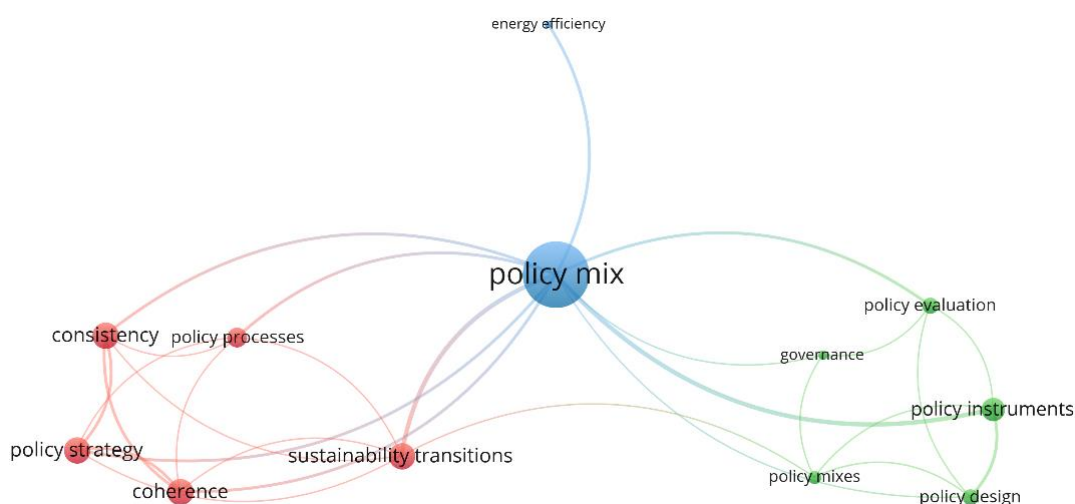


Figure 6 Keywords Network visualization of Literature Selected under the Policy Mix topic

While combining the search of Policy Mix, Policy Coherence, Climate and Sustainable Transitions, Energy Policies appeared as a common and recent topic on how policy mix is important to attain sustainable transitions (Böhringer et al., 2016; Costantini et al., 2017; F. Kern et al., 2017; Marquez-Ballesteros et al., 2018; Rogge & Reichardt, 2016; Solorio, 2011).

Furthermore, Energy appears directly in the Policy Mix literature keywords (Energy Efficiency in blue) but, as it will be explained in the Energy Poverty segment of this theoretical background, the discourse on the sustainable transitions and complex problems relate to the multitude of drivers, factors and outcomes of the Energy Poverty. Therefore, Energy Poverty combines the complex problematic nature and mix of different fields which are common points addressed in the Policy Mix and Policy Coherence studies.

In conclusion, the state of the art on the three concepts will be presented to fundament and clarify their current definitions and relation between each other. Policy Coherence and Policy Mix will be developed separately since the former is being addressed in a clear and separate form of the Policy Mix literature and with common lines to analyse the policies being used for sustainable transitions. It will also be noted Policy Coherence literature is more holistic than the how Policy Mix consider coherence as characteristics and criteria for evaluation.

2.3. POLICY MIX

The concept of policy mix emerged during the 1960's as an analysis between the way fiscal and monetary policies could be related in economic policy: *“monetary and fiscal policy can be used as independent instruments to attain the two objectives if capital flows are responsive to interest rate differentials, but it is concluded that it is a matter of extreme importance how the policies are paired with the objectives”* (Mundell, 1962). In the excerpt we can see the mention of how the objectives should be related in a way to attain a successful articulation between policies. However, when it comes to urban policies and the evolution of the concept, some questions appear:

- Are the objectives the only way policy mixes can articulate?
- How are policy mix currently being applied?
- What type of problems can appear with this way of using policies?

To analyse these questions, we need to understand the way Policy Mix is currently being used and how authors agree with its definition. The use of policy mix in general policy sciences started during the late 1980's and early 1990's to explore how multiple policies and instruments could answer desired inputs and outputs (Flanagan et al., 2011; Rosenow et al., 2016). In the first decade of the current millennium, policy-makers and analysts understood that innovation, sustainable transitions and Research and Development (R&D) policies were facing the use of multiple goals, instruments and actors (Magro & Wilson, 2019; OECD, 2007, 2012; Ring & Schlaack, 2011). Following Tinbergen's rule of economic policy, which defends multi-aspects problems should have a policy instrument per target to avoid redundancies (Tinbergen, 1952), the current discourse present in European Union (EU) and Organisation for Economic Co-operation and Development (OECD) about sustainable transitions faces the need of comprehending how to combine multi-level, multi-instruments and the mix of goals within policies to answer the complexity of its problems (Diercks, 2019; Edmondson et al., 2019; Kurowska-Pysz et al., 2018; OECD, 2018b; Solorio, 2011).

There is still not a common definition of policy mix and three types of literature discuss different aspects of the subject. First, authors define the elements in consideration when approaching policy mix. In this type of literature, there is a recognition of evolution of the concept, starting by focusing on the mix of instruments and ending involving policy process, elements, characteristics, dimensions and its interactions and dynamics. Second, literature justify the concept use in different fields. Third, there are studies and discussion of different approaches to analyse policy mix. To achieve a holistic definition of policy mix, we will focus in these three types of literature, where we will review the literature to each point and assembled the current information of them, and add a fourth point:

1. Understand policy mix elements.
2. Justifying its current use and importance.
3. Methodology to analysis and its complexity.
4. Current problems brought from its use.

2.3.1. DEFINITION

Policy Mix does not have a universal definition and there is a double perspective of the concept: the mix of instruments and policy process and instruments mix. Instrument mix was used as synonym of policy mix but it is only a part of policy mix forasmuch as policy process or strategy, inputs and outputs, actors and actions are also part of policy mix (Flanagan et al., 2011). In table 2, different definitions of policy mix were collected from various studies.

Table 2 Definition of Policy Mix by different authors

Policy Mix	(Flanagan et al., 2011)	<i>“Interactions and interdependencies between different policies as they affect the extent to which policy goals are realized.”</i>
	(Ring & Schlaack, 2011)	<i>“Combination of policy instruments which has evolved to influence the quantity and quality of biodiversity conservation and ecosystem service provision in public and private sectors.”</i>
	(Howlett et al., 2017)	<i>“Bundles of individual policy instruments or tools and techniques used by government in order to achieve their policy goals”</i>
	(Magro & Wilson, 2019)	<i>“Policy mix is not only made up of concrete elements (instruments), but also by processes (policy-making) and their characteristics (mainly consistency of elements, coherence of processes, credibility and comprehensiveness)”</i>

As can be observed, there is not a clear definition of Policy Mix by the different authors. However, the existence of multiple instruments, their elements and their interactions appear to be the focus of the different definitions. The next subsections will further present how the different authors interpret the concept under different scopes to clearly sustain the structure of the Policy Mix concept.

2.3.2. JUSTIFICATION, CONCEPTS AND COMPLEXITY

In 2010, OECD recognised how Policy Mix concept has become popular, especially when it comes to innovation policies, table 3 (OECD, 2010). To analyse the concept, it starts by identifying the elements and dimensions of policy which are represented in the following table:

Table 3 Elements and dimensions of policy identified based on OECD (2010)

ACTORS AND FACTORS		DIMENSIONS OF POLICY	
Actors	Types of organization and intermediary bodies	Domain areas	Variety of policy sub-systems
Structures	Material and other resource factors	Rationales	Justification for policy intervention and causes of underperformance
Institutions	Rules and codes of conduct that reduce uncertainty	Strategic tasks	Direction of policy intent
Ideas	Socio-cognitive frameworks	Instruments	Techniques for action to meet strategic tasks

Then, two meanings for policy mix are defined. On the one hand, the detecting paper of the policy mix is to diagnosis the dynamics and performance of the policies. On the other hand, the effecting role of policy mix is a framework to design policies.

Figure 7 shows how this two meaning are not alternative, but complementary and interdependent. They can be related in a wider political and socioeconomic situation where two types of use of policy mix can occur by detecting, when it uses existing policies, or effecting, when it designs polices. The relation between four dimensions of policy and their interactions with the actors and factors defined in table 3 are also observed.

In the chapter *The Innovation of Policy Mix*, it is also mentioned the importance of policy coherence as an extension of policy mix to “points to the co-ordination of a multitude of policy actions” and an “evaluation of their possible interaction with policies pursuing other primary objectives”.

Flanagan et. Al (2011), following the dimensions defined by OECD 2010, mentioned the complexity of policy mix and how co-ordination “can in principle be done by a single, objective, rational and neutral overseeing policy maker” but “in a world of dispersed, multi-level and multi- actor governance patterns ‘co-ordination’ in this sense is clearly impossible”. It is also stated the difference between meta-rationales which are “high-level philosophies about the proper modes and limits of government action” and “the adoption of which is guided by the meta-rationales in operation at the higher level”, specific policy rationales. The last one is the starting point of evaluation pol policy action effectiveness (Flanagan et al., 2011). It is taken special attention to the dimensions (across

policy, governance or geographical space and time), types ¹and potential sources of tension (conflicts between policy rationales or goals and implementation approaches) within interactions in the policy mix.

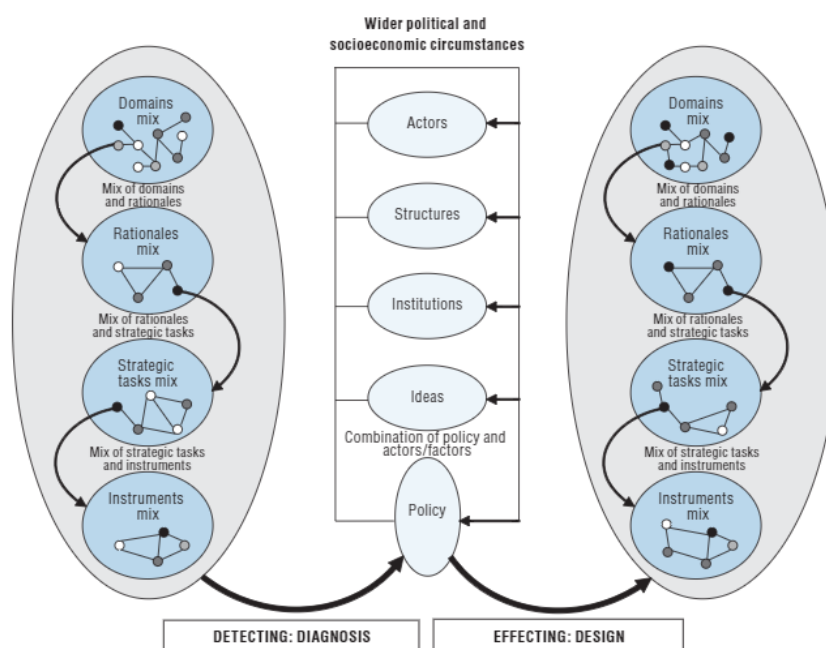


Figure 7 Relation of the two different meanings of policy mix. Source: (OECD, 2010)

Furthermore, there is an importance on understanding the complexity of dimensions and interactions to take in consideration when studying the evaluation or designing of policy mixes (Edmondson et al., 2019; Howlett & Del Rio, 2015; Rogge et al., 2017; Rogge & Reichardt, 2016). Howlett and Del Rio (2015) start by identifying two types of level to take in consideration of complexity of policy mixes. The **horizontal level** takes in account the “*kind of relationships existing between tools, goals and policies within a single level of government and sector of policy making*” and the **vertical level**, normally less presented or ignored in studies, involves “*not just the number of instruments, goals and policies found in a mix, but also the number of policy sectors they involve and the number of governments active in policy formulation in this area*” (figure 8). The latter is relevant when accessing the coordination issue and may require adaptation of the existing mixes when shifts occur.

¹ Flanagan et. Al (2011) identify interaction between (1) “‘different’ instruments targeting the same actor/group (within/ across dimensions), (2) ‘different’ instruments targeting different actors/groups involved in the same process (within/across dimensions), (3) ‘different’ instruments targeting different processes in a broader system (within/across dimensions) and (4) ‘the same’ instruments (across different dimensions)”

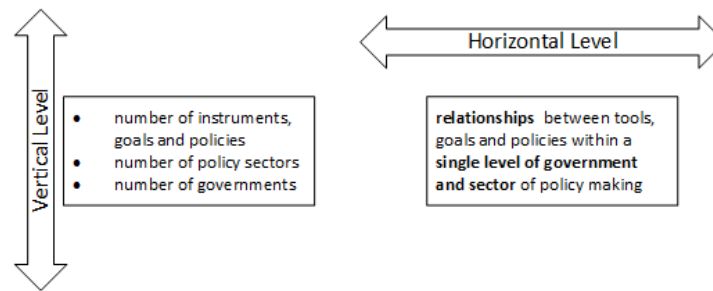


Figure 8 Levels of policies

When it comes to the development of a basic taxonomy of policy mixes -table 4-, eight dimensions are identified of portfolio designs when considering three elements: multilevel of governance, multi-policy and multi goal. Four types are considered policy mixes: (1) Simple Single-level Policy Mix; (2) Complex Single-level Policy Mix; (3) Simple Multi Level Policy Mix; and (4) Complex Multilevel Policy Mix. The other four are considered instruments mixes since they consider single policy contexts. The most complex type of policy mix is the last one, having present the three elements used to the classification (Howlett & Del Rio, 2015).

Table 4 Taxonomy of policy mixes. Source: (Howlett & Del Rio, 2015)

Dimension	Types							
	I	II	III	IV	V	VI	VII	VIII
Multilevel	No	No	No	No	Yes	Yes	Yes	Yes
Multi-policy	No	No	Yes	Yes	No	No	Yes	Yes
Multi-goal	No	Yes	No	Yes	No	Yes	No	Yes
	Simple Single-level Instrument Mix	Complex Single-level Instrument Mix	Simple Single-level Policy mix	Complex Single-level Policy mix	Simple Multilevel Instrument Mix	Complex Multilevel Instrument Mix	Simple Multilevel Policy mix	Complex Multilevel Policy mix

In sum, the complexity of policy mixes becomes higher when there are more mixes in different elements and levels. In figure 9 , we can see the representation of the growth of complexity based on the three elements (Howlett et al., 2017). Although it is important to categorise policy mixes to be able to analysis policy mix, it is important to mention that it becomes difficult to identify in which category policies belong. On a study to understand the role of policy mix and evaluation, (Bouma et al., 2019) distinguish policy objective mixes from policy instruments mix. The former represents “*combinations of instruments aimed at multiple policy objectives*” and the latter “*combinations of instruments aimed at a single objective, or policy goal.*” Moreover, it is discussed that there is not an universal rule to define single or multiple objectives/instruments this matter makes the evaluation of policy mixes more complex.

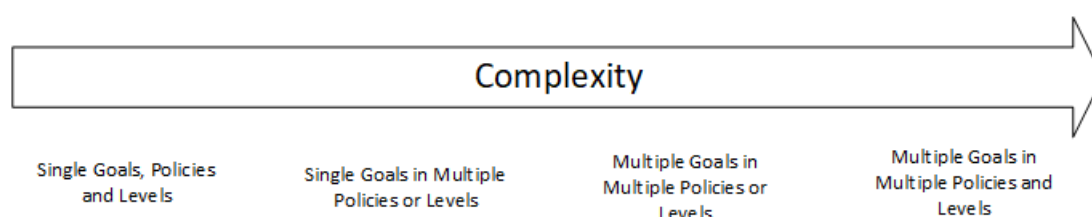


Figure 9 Growth of Tool mix' complexity adapted from (Howlett et al., 2017)

In summary, there is a vast of studies considering instruments and their interaction as policy-mixes. However, other elements take part of the concept such as policy process and policy strategy (Costantini et al., 2017; Edmondson et al., 2019; Lindberg et al., 2019; Rogge & Reichardt, 2016).

Rogge and Reichardt (2016) define three blocks of policy mix: **elements**, **policy processes** and **characteristics**. These elements are further described, since it is important to not fall in an ambiguous definition of policy mix and captured their complexity and dynamic nature.

Elements (table 5) “comprise the (i) policy strategy with its objectives and principal plans for achieving them and (ii) the instrument mix with its interacting policy instruments” (Rogge & Reichardt, 2016). Here, we have the different topic which is less mentioned as part of policy mix- policy strategy- and it is considered as “a combination of interdependent ends (goals) and means (policies) to achieve the ends”. This is where actors define a guidance to develop concrete instruments which, themselves, can be part of a way to evaluate policy mix, for instance, in the field of sustainable transitions (Lindberg et al., 2019). Instruments and their mix are the concrete elements and influence the inputs and/or outputs, making possible the achievement of policy objectives. For that reason, it is the most focused component in policy mix.

Table 5 Elements of Policy Mix based on (Rogge & Reichardt, 2016)

ELEMENTS	Policy strategy	Objectives			
		Targets			
		Principal plans			
	Instruments	Types	Economic instruments		
			Regulation		
			Information		
		Design feature	Descriptive	Target actors, and its duration, summarize the content of a policy instrument	
			Abstract	Stringency	Ambition level of an instrument
				Level of support	Magnitude of positive

			incentives	
			Predictability	Degree of certainty
			Flexibility	Freely choose way to achieve compliance
			Differentiation	Description of the target
			Depth	Range of incentives
Instrument mix	Types of instruments	Core instruments		
		Complementary instruments		
	Interaction	Influence between instruments	Direct effect	
			Indirect effect	

Policy processes (table 6) determine the strategy, instruments and characteristics and change over time. Governments are the most important factor to the concept and it covers all “*all stages of the policy cycle, including problem identification, agenda setting, policy formulation, legitimization and adoption, implementation, evaluation or assessment, policy adaptation, succession and termination*” (Rogge & Reichardt, 2016).

Table 6 Policy Process in Policy Mix based on (Rogge & Reichardt, 2016)

POLICY PROCESS	Policy making	Definition	<i>"Cycle of problem-solving attempts, which result in 'policy learning' through the repeated analysis of problems and experimentation with solutions"</i>
		Key features	Policy adaptation
			Policy learning
	Policy implementation	Executing and enforcing policies	
	Style	<i>"Standard operating procedures for making and implementing policies"</i>	

Finally, characteristics (table 7) are the key features which make possible to analysis and comprehend how the policy mix occurs. Policy Coherence reveals as the most discussed subject when analysing

policies in sustainable transitions. OECD has multiple publications² about Policy Coherence for Sustainable Development (PCSD) and a vast of studies are developed around policy coherence to achieve Sustainable Development Goals (SDG) and sustainable transitions (Breuer et al., 2019; Brodhag & Talière, 2006; Chan et al., 2021). The dimensions takes special attention of policy mix in the discourse of governance which is a recent topic in Europe and there are studies analysing the mix between and within horizontal and vertical levels (Breda-Vázquez et al., 2010; Howlett et al., 2017; Magro & Wilson, 2019).

Table 7 Characteristics of Policy Mix based on (Rogge & Reichardt, 2016)

CHARACTERISTICS	Consistency	Definition	<i>"How policy mix elements are aligned and contribute to the achievement of objectives"</i>	
		Key features	State of the elements	
			Relative terms	Degree
				Variation across dimensions
		Levels	Policy strategy	
	Instrument mix			
	Instrument mix with policy strategy			
	Coherence	Definition	<i>"Synergistic and systematic policy making and implementation processes contributing – either directly or indirectly – towards the achievement of policy objectives."</i>	
		Key features	Across different policy fields and governance levels	
			Systematic capabilities of policy makers	
Direct and indirect effect				
Tools		Policy integration		
	Coordination			
Credibility	Extent to which the policy mix is believable and reliable			

² For further reading, consult the Toolkit for PCSD on the website of OECD (OECD, 2021b)

Comprehensiveness	<i>"how extensive and exhaustive its elements are and the degree to which its processes are based on extensive decision-making"</i>		
Dimensions	Policy field		
	Governance level	Vertical	
		Horizontal	
	Geography		
	Time	Elements	
		Processes	
Characteristics			

In brief, policy mix appears in different scientific fields such as economic, innovation, energy, climate and policy studies. There are currently three major elements to understand policy mix and they are dynamic and interact with each other. In figure 10, Rogge and Reichardt summarized the application of policy mix in a framework to analyse and evaluate them in technological change interests. This subject will be further analysed in the next segment.

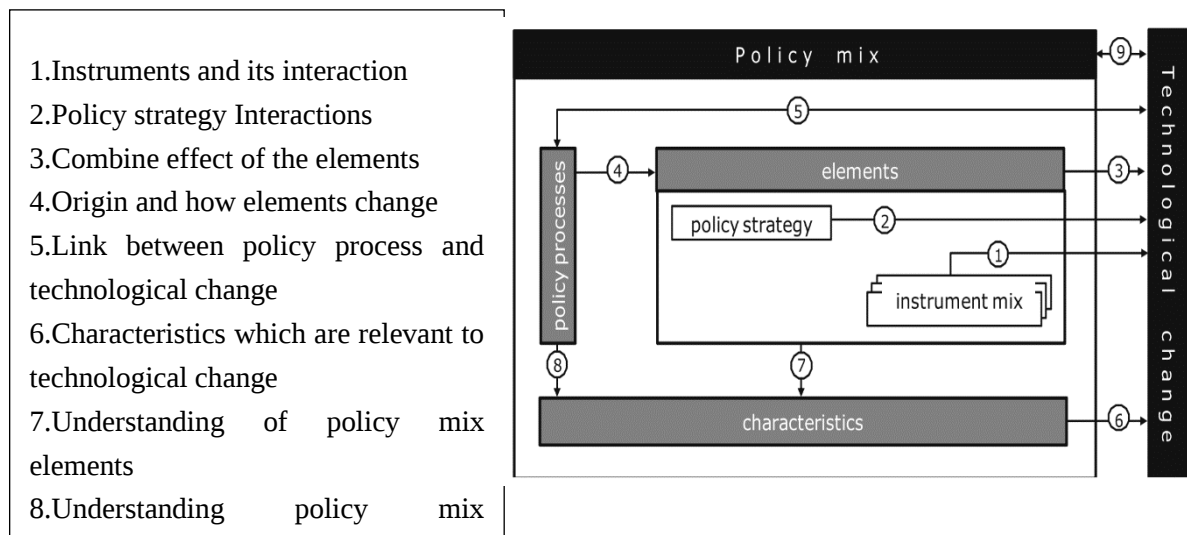


Figure 10 Framework for analysing the link between the policy mix and technological change adapted from (Rogge & Reichardt, 2016)

2.3.3. POLICY MIX ANALYSIS

Policy Mix Analysis takes special attention to the study of interactions between its elements differencing itself from traditional Analysis of Single Instruments which aims to compare the quality of instruments (Ring & Schlaack, 2011).

The complexity of Policy Mix has been a difficulty to trace and universal model for its analysis too. Although there is not common model to assess Policy Mix, different and experimental methods are being taken to further test and propose new methods for Analysis (Bouma et al., 2019; Magro & Wilson, 2019). Hence, Policy Mix Analysis can be seen as a framework rather than a model (Ring & Schlaack, 2011).

The complexity of Policy Mix also limits the type of studies which can take place in different policy fields. Although the taxonomy of policy mixes being already a step to select the framework to policy mix analysis, Rogge and Reichardt (2016) identify two key challenges for analysts. First, there is a need to set boundaries: (1) understand the complexity of the subject, (2) define the unite of scales, for instance, deciding which actors take place on the analysis and (3) understanding boundaries are iterative and may change during the process. Second, after the delineation of the policy mix study, the analyst may capture the instruments, policy strategy, policy process and characteristics.

Ring and Schlaack (2011), in their policy mix report *assessing the role of economic instruments in policy mixes for biodiversity conservation and ecosystem services*, distinguish two pathways to analysis based on time dimension and existence of instrument. In on hand, Ex Post analysis take place “*In a specific context and at a certain point in time*” and “*a mix of existing instruments is usually already present*”. On the other hand, Ex Ante analysis occurs when “*A new policy instrument is to be introduced against a background of already existing instruments and both the new and the existing ones form the policy mix*”. Both pathways can focus on the intrinsic instruments or their complementary or conflictual interaction. The last one has become the focus of recent literature as will be further exposed.

Mavrot et al. (2018) start completing the Rogge and Reichardt (2016) policy mix analysis framework by adding settings and target groups to their model. The authors argue that policy mix analysis should not only focus on the form of policy instruments but also their context of implementation. Settings are identified as the “*specific context in which policy instruments are implemented*” and target groups how the instruments interact. Moreover, special attention is given at the micro-level where interaction between target groups and policy instruments take place. In summary, the adopted policy mix by the authors are based on four aspects of the Rogge and Reichardt (2016) blocks of policy mix which are identified in figure 11 (Mavrot et al., 2018; Rogge & Reichardt, 2016).

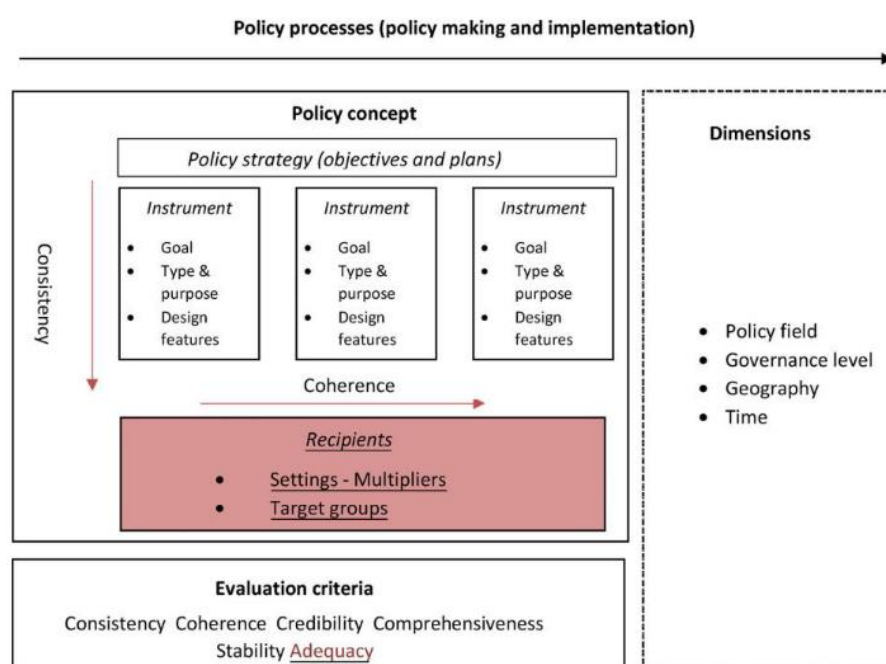


Figure 11 Policy Mix framework analysis including Settings and Target Groups. Source: (Mavrot et al., 2018)

As can be observed in the previous figure 11, Consistency is considered as the criteria for single instrument analysis while Coherence evaluates the interaction of the policy instruments. The elements, which Mavrot et al. (2018) call policy concept, combine the interaction of policy instruments and the policy strategy. Policy processes designate the policymaking and implementation while the dimensions, as have been previously identified, qualify the policy context. The most relevant contribution of this study is the application of characteristic of policy mix by Rogge and Reichardt (2016) as the evaluation criteria and stability and adequacy addition.

Bouma et al. (2019) identify three steps to evaluate policy instrument mixes: (1) disentangle the policy mix, specially focusing on the policy objectives and means, (2) understanding if the mix occurs on the objectives or instruments³ and (3) selection of the existent methodologies to define a framework. The typical methods based on multi-criteria, cost-effectiveness and cost-benefit need to set boundaries for their application. Since Policy Mix does not have a clear point nor baseline to distinguish their policies and, in summation to the complexity of the interactions the instruments, these methods are difficult to apply for Policy Mix analysis (Bouma et al., 2019; Ring & Schlaack, 2011).

Lindberg, Markard and Andersen (2019) studied Energy Policy Mix in European Union (EU) focusing on its policies and actors. They start by collecting and selecting the data and explain the process to the final elements considered. Next, they present the coding scheme used to categorize

³ The authors discuss that policy objectives mixex is political question and policy instrument mix depend on relevant market, governance and behavioural failures.

actors and policies. Finally, to conclude their framework of policy analysis (figure 12), there is an explanation on the operationalization of elements and the criteria used to weight them.

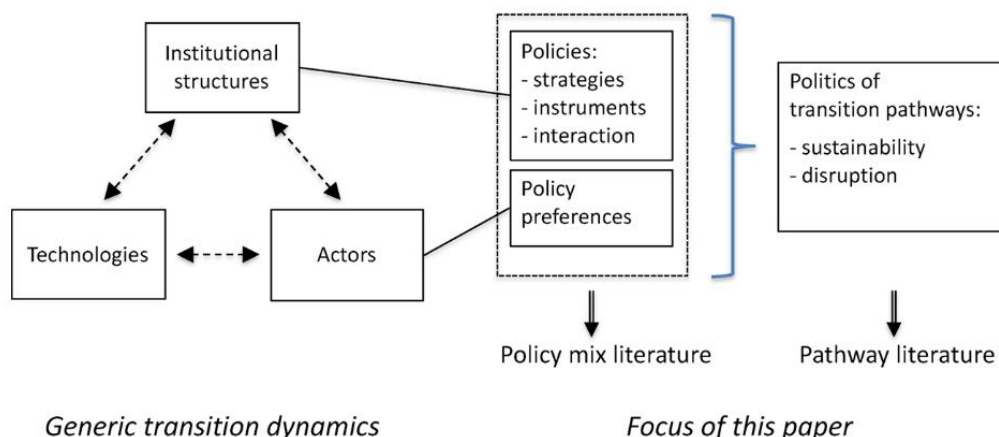


Figure 12 Framework of Policy Mix Analysis used by (Lindberg et al., 2019)

Magro and Wilson (2019) evaluate policy mix by studying the challenges pluralistic contexts of governance in Basque Country. The authors mention a new aspect to policy mix concept: **directionality**⁴. Three governance modes are identified by taking a strategic learning tool to understand how policy mixes contribute to policy mix and how actors' behaviour changes. The modes are characterized depending on three elements: government, policy makers, stake holders. The mode 3 of governance for policy mix evaluation entails the more complex scenario and it is mentioned stakeholder-evaluation as a method to analyse this kind of scenario.

Edmondson, Kern and Rogge (2019) “develop a novel conceptual framework for analysing the co-evolution of policy mixes and socio-technical systems in processes of sustainability transitions”(Edmondson et al., 2019), figure 13. Then, it is taken an empirical illustration of the framework on the policy mix on United Kingdom zero carbon homes. First, they start by collecting and analysis of “policy documents, industry journals, secondary literature, government consultations, select committee publications, inquiries, and debates in the House of Commons and House of Lords over the period 2006–2016”. Then, following a top-down approach, they identify the policy mix by considering the targets and instruments. These are then analysed by the feedbacks and effects identified in figure 13.

⁴ Directionality is considered an issue since there is more focus on the complementarity between instruments but the direction, or neutrality, of instruments are not taken in consideration making it a challenge to build policy mix that “explicitly target prioritised activities through experimentation” (Magro & Wilson, 2019)

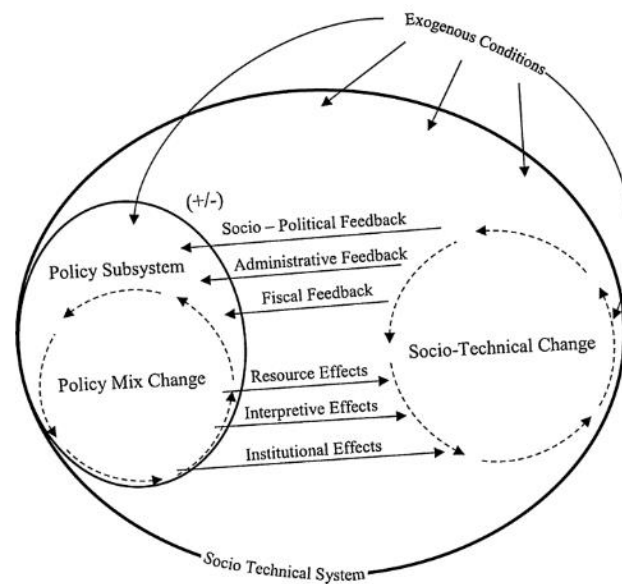


Figure 13 Policy Mix and Social-technical system: framework of policy analysis. Source: (Edmondson et al., 2019)

Rosenow et al. (2016) analyse the policy mixes in 14 EU countries' energy efficiency policy. They start by collecting and separate policy instruments based on European Energy Directive (EED) and then characterize them by function, underlying theory of change and behaviour type in a two-entry table which helps to identify how different policy types can deliver the same intervention. Thus, there were 11 policy types identified which would result in 160 combinations if three policy types were considered, it is explained how this would not be useful for the report and therefore the study only focus on bipartite policy mixes combination and the criterion used to judge it is the effectiveness of the combination on saving energy when compared to the single use of the policies. The study also assumes that the policy instruments take place at the same sector and time.

Policy mix analysis is a step to understand how the optimal policy mix would address an issue. Policy design can be summarized in three steps: *“(1) a primary selection of the specific instruments most suitable among the wide range of different possible instruments; (2) the concrete design and/or ‘customization’ of the instruments for the context in which they are supposed to operate; and (3) the design of an instrument mix, or set of different and complementary policy instruments, to address the problems identified”*(Rosenow et al., 2016). It is important to mention that this is a brief summary of policy design and that it is much more complex to define because of its political characteristic.

In general, the studies discussed have a similar approach when it comes to policy analysis. First, the authors start to understand the concept of policy mix and the field it is being studied. Here, normally occurs the literature revision where the most important concepts of the study are given a definition. Second, it is collected the instruments and/or information needed to define the dimension of the analysis and its focus. Some studies focus on the instrument mixes, other on actor and their level mixes and other combination of elements of policy mixes, previously described by the authors, are taken in consideration to analyse the specific field. Because of the number of possible combinations of

the elements, their dynamic and multi-aspects, it is understood the need to limit the analysis and, therefore, the third stage appears to define the mixes which will be evaluated. Fourth, it is designed the framework of approach to analyse the collected instruments, the type of evaluation used and the criteria. Currently there is not a universal method to approach the complex, interchangeable and dynamic features of policy mix and, thereupon, experimental and mix of methods are used to policy mix analysis. Finally, in the five stages, authors analyse the results, identify the limitation of their studies and give recommendations to further analysis on the subject they have developed. Moreover, the complexity and dynamic of the nature of policy mix never stop during the analysis, making it an iterative and learning process.

2.4. POLICY COHERENCE

2.4.1. DISTINGUISHING POLICY COHERENCE FROM COORDINATION AND POLICY INTEGRATION

When addressing multidimension, cross-cutting and complex problems, Policy Coherence is seen as an important subject to analyse different policies, actors, instruments, and their interactions. Authors focus on how they are related but not the same and should be seen as a process when addressing the complexity of problems (Cejudo & Michel, 2017; Moure et al., 2021).

In addition to Policy Coherence, tables 8, 9 and 10 will also summary the definitions of the concepts by different authors of Policy Integration and Coordination. The goal of this latter definitions are to distinguish the different concepts which are not only present on the literature on Policy Coherence but also of the Policy Mix.

Table 8 Definition of Policy Coherence by different authors

Policy Coherence	(Cejudo & Michel, 2017)	<i>"The process where policy makers design a set of policies in a way that, if properly implemented they can potentially achieve a larger goal"</i>
	(May & Jochim, 2013)	<i>"Consistency of actions in addressing a given set of policy problems or target groups."</i>
	(OECD, 2018a)	[PCSD] <i>"Approach and policy tool to systematically integrate the social, economic and environmental dimensions of sustainable development at all stages of domestic and international policy-making"</i>
	(OECD, 2019)	[PCSD] <i>"The perusal of policies and actions involving different stakeholders (government and non-governmental actors, agencies and institutions) at various levels (local, national, regional and global) to achieve development objectives by domain (area, sector, goal and target) and minimize conflicts affecting the utilization of synergies generated in the process."</i>
	(Chan et al., 2021)	<i>"The achievement of goal coherence is dependent on multiple implementation levels and processes, such as adequate public</i>

administrative practices and the substantive engagement of various stakeholders”

As can be observed in the different definitions, there is a relation of Policy Coherence with Policy Mix since recognises the multi-level and goals of policies and also the mix of instruments. Policy Coherence in literature, as will be further presented when defining the Policy Coherence Blocks segments, appears to integrate Policy Mix, Coordination and Integration in its definition and sequent analysis.

Table 9 Definition of Coordination by different authors

Coordination	(Cejudo & Michel, 2017)	<i>“A process in which members of different organizations define tasks, allocate responsibilities, and share information in order to be more efficient when implementing the policies and programs they select to solve public problems”</i>
	(Chan et al., 2021)	<i>“Processes that bring together various institutions and actors to mutually formulate policies, standards, and procedures.”</i>
	(Flanagan et al., 2011)	<i>“Coordination can at best mean mutual adjustment between actors and systems within this larger system of systems.”</i>

Coordination, on the other hand, has a common line on its different definitions which consider the observation of the interactions between the different policy elements. This concept is related to Policy Coherence and Policy Mix since this observation is important to analyse the elements of latter concepts.

Table 10 Definition of Policy Integration by different authors

Policy Integration	(Cejudo & Michel, 2017)	<i>“The process of making strategic and administrative decisions aimed at solving a complex problem. Solving this complex problem is a goal that encompasses- but exceeds- the programs and agencies’ individual goals”</i>
	(Mickwitz et al., 2009)	<i>“The incorporation of the aims of climate change adaptation and mitigation into all stages of policy-making in other policy sectors (non-environmental as well as environmental); -complemented by an attempt to aggregate expected consequences for climate change adaptation and mitigation into an overall evaluation of policy, and a commitment to minimize contradictions between climate policies and other policies”</i>

	(Howlett et al., 2017)	<i>“The smooth coexistence of the different elements of policy, including goals, policies and government levels involved in policy mix design and creation, so that conflicts are minimized and, if possible, synergies and complementarities are promoted.”</i>
	(Chan et al., 2021)	<i>“Integration is achieved by fostering synergies and by identifying and reconciling trade-offs between competing goals and objectives of the three development dimensions and of national and international policies”</i>

Finally, Policy Integration normally appears associated to Policy Mix, Coordination and Coherence. This concept focus on how the different policies interact and accomplish the established goals on different policy fields.

2.4.2. POLICY COHERENCE BLOCKS

Several international cooperation instruments are currently being applied such as Paris Agreement, Sustainable Development Goals and New Urban Agenda. **Moure et al. (2021)** study the implementation of these policies, considered Post-2015 Agenda, in terms of the coherence of their implementation in Mexico. Agenda coherence is considered as the implementation of Post-2015 agenda to achieve goals more effectively and efficiently. The study collects the literature and analyses different levels, interactions, and sectorial features of coherence (figure 14).

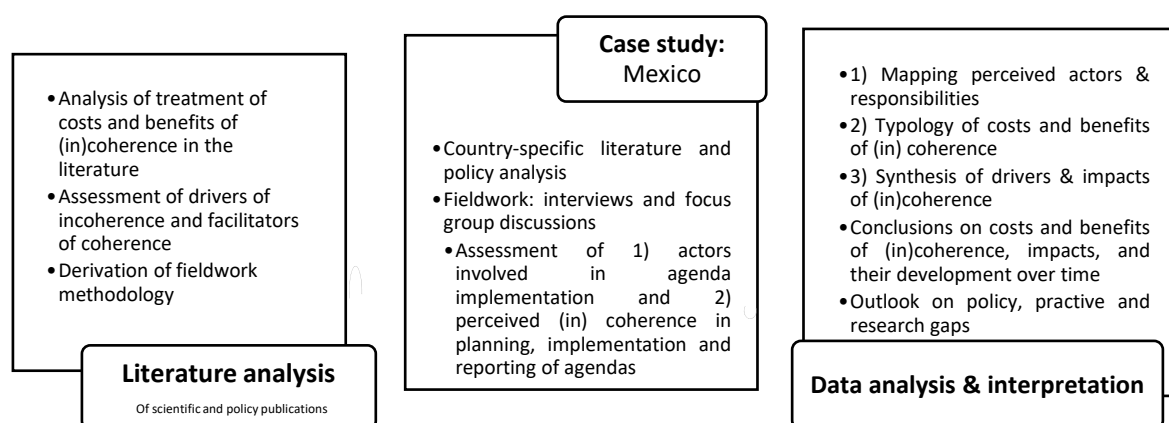


Figure 14 Methodology Process of Moure et al. (2021) for analysis of (in) coherence in Post- 2015 Agenda in Mexico. Source: adapted from (Moure et al., 2021)

Although authors do not consider Policy Mix in the study, they collect the various policies which take place in Mexico, analyse actors, programs mechanisms and instruments by focusing on providing an “overview of key areas of (in)coherence, the root causes and challenges to overcome them, and the human experience in the process”(Moure et al., 2021). Fieldwork is developed by interviews and group discussion with the stakeholders of 17 key institutions identified for the implementation of Post-

2015 Agenda. Then, using MAXQDA software, the transcripts and notes are analysed by an iterative process.

Coherence is associated by the participants as “*integration, alignment, coordination and cooperation*” keys which are aligned with the ones identified by the authors on the collected literature. The results are then presented in four points: perception of responsibility, manifestations of (in)coherence, drivers of policy incoherence and ultimate costs and impacts. In total, 6 drivers are identified as the drivers of incoherence in policy implementation: (1) *Temporal mismatch*, i.e., the presidency times and changes in the alignment of government causes uncertainty in the implementation; (2) *Discontinuity and rupture*, for instance, the problems caused of the first driver on the length of implementation; (3) *A heavy bureaucracy with strict hierarchies* induce incongruency between of the incentive to decentralization and the reality of mandatory tasks defined for achievement from the top of hierarchy; (3) *Working silos with budgetary rigidity* which makes difficult to application of funds in agencies for a wider scope of initiatives; (4) *Disconnection between planning and implementation* related to the disconnection between high-level circles and local realities. (5) *Knowledge and capacity disparities* present between the reports and the information used to planning and implementation.

Lastly, in the discussion, authors present a summary of the costs, benefits and impacts of coherence in two different scenarios which are identified in figure 15.

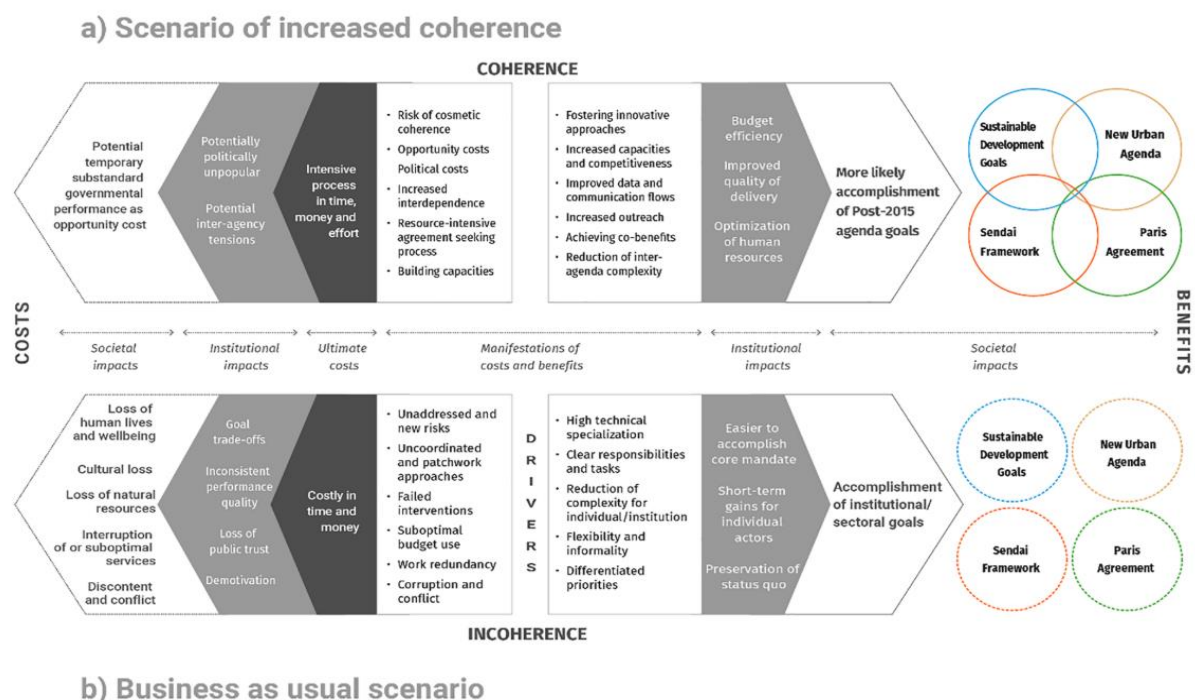


Figure 15 Typology of costs, benefits and impacts of agenda coherence in Mexico in a) an increased coherence scenario, and b) a business as usual. Source: (Moure et al., 2021)

The Post-2015 Agenda is a recent topic of sustainable development (Breuer et al., 2019; Chan et al., 2021; Chaturvedi et al., 2021). OECD has various publications discussing policy coherence to achieve sustainable development which are identified in 17 Sustainable Development Goals (SDG) and noted their application in Policy Coherence for Sustainable Development-PCSD,(OECD, 2016, 2018b, 2019). In the later publication, it is identified five goals, targets and interactions between them to “*capitalise on policy synergies and to avoid or minimise costly trade-offs – ultimately enhancing the overall effectiveness and impact of policies and actions*”: (SDG 4) quality education, (SDG 8) decent work and economic growth, (SDG10) reduced inequalities, (SDG13) climate actions and (SDG16) peace, justice and strong institutions. In chapter 2, eight key areas are highlighted as institutional mechanism for achieving PCSD. Those key features are considered the blocks of policy coherence and are defined on table 11.

Table 11 Blocks to Policy Coherence for Sustainable Development

1. Commitment and leadership	To mobilize whole-of-government action, and translate commitment to PCSD into concrete measures at the local, regional, national, and international levels;
2. Long-term vision	To reconcile short- and long-term priorities and make informed choices about sustainable development considering the long-term implications of today's policy decisions on the well-being of future generations;
3. Policy integration	To integrate sustainable development into policy and finance, and capitalize on synergies, manage trade-offs between economic, social, and environmental policy areas, as well as to ensure consistency with internationally agreed goals
4.Coordination	To anticipate and resolve divergences between sectoral priorities and policies, and ensure mutually supporting efforts across sectors and institutions for sustainable development;
5.Regional and local involvement	To align priorities and ensure coordinated action and consistency across all levels of government for sustainable development;
5.Stakeholder engagement	To ensure that PCSD measures are understood and accepted by the population and supported by key stakeholders; those actions are aligned; and that knowledge and resources for PCSD are mobilized
6.Policy impacts	To provide decision-makers with informed evidence on positive and negative impacts of domestic policies on sustainable development at home and abroad (transboundary impacts);
7.Monitoring and reporting	To collect and evaluate information on the impact of policies on sustainable development, and report regularly to governing bodies and the public about progress on PCSD and on how policies have been implemented regarding the

SDGs and adjusted considering negative effects.

In summation to the publications of OECD, there is a website called PCSD Toolkit (OECD, 2021b) where the blocks of PCSD are presented in an iterative way to “*guide decision-makers and practitioners in: (1) Conducting analysis to improve understanding on the interactions among SDGs and targets (synergies and trade-offs) and their implications; (2) Strengthening existing institutional mechanisms which can support a more coherent and integrated implementation of the SDGs; and (3) Identifying options for monitoring, assessing and reporting progress on policy coherence for sustainable development.*”. A part of the website focus on self-assessment and presents a checklist⁵ with key elements to assess practices to PCSD. In summation, Good Practices, Tools and Guidance are presented to share the knowledge about the subject. Both, publications and website, are aligned with the 2030 Agenda (United Nations, 2018) and 5 blocks of PCSD are mentioned in the later: integration, long-term vision, policy impacts, regional and local involvement and stakeholder engagement.

2.4.3. RELATIONS

Chan, Iacobuta and Hägele (2021) focus in three governance discussion *The Palgrave Handbook of Development Cooperation for Achieving the 2030 Agenda* (Chan et al., 2021): coherence, polycentricity and coordination. While discussing the definition of **coherence** as a “*variety of understandings, including coherence between actors, between levels of governance, between various policies and goals, and between goals and resources*”, authors mention **policy synergies** as “*a mix of (two or more) policies complement each other in a way that enables greater achievements than the sum of individual policies, as the policies reinforce one another*” which characterizes the use of policy mix. Policy integration is considered essential to achieve coherence and the engagement of stakeholders, horizontal and vertical levels are identified as the three dimensions for analysis in policymaking. In figure 16, it is presented the multiple elements of policy coherence identified in the study and their key elements demonstrating the relationship of the various concept to achieve the goal of coherence.

Taking the elements previously identified used to analyse policy coherence, Cejudo and Michel (2017) address the fragmented government action by identifying policy integration as a solution and argues how “*coordination, coherence, and integration are related, but substantively different concepts*” and show how they can be used to analyse policy design and implementation. The concepts are defined on figure 17 and objects, attributes, develop scales and pose questions are also identified and are applied to analyse the case study of Mexico’s National Crusade against Hunger which is “*a strategy for coordination among federal agencies and levels of government*” promotes “*coherence among social*

⁵ The checklist can be consulted online or download as PDF format (OECD, 2021c)). It consists in two to five questions to each element and in the final of each key there is a link to Guidance and Good Practices of the website.

programs” and aims “at policy integration by fostering decision making toward addressing extreme poverty instead of agencies’ and programs’ individual goals.” (Cejudo & Michel, 2017).

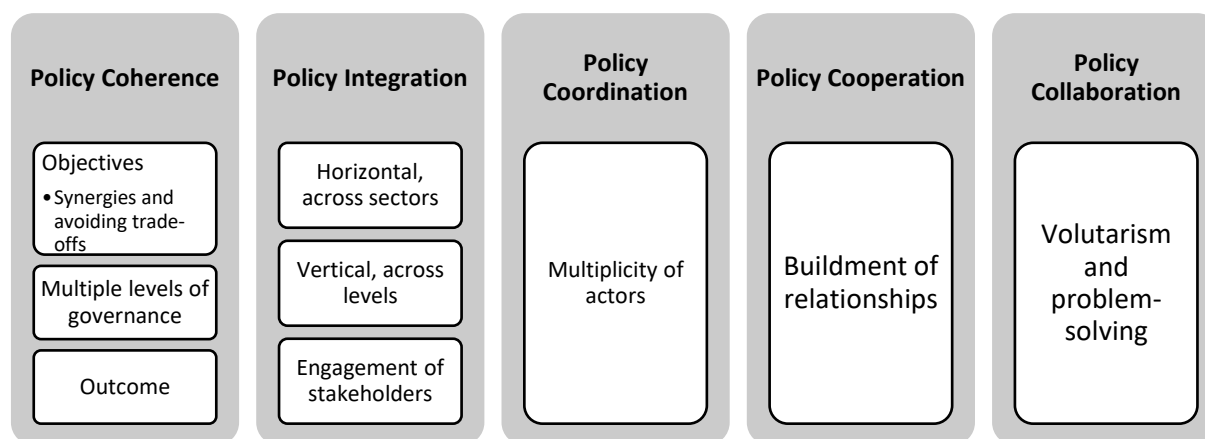


Figure 16 Elements of Policy Coherence and their key elements

As seen in figure 17, three attributes are identified of policy coherence. Coherence among goals aims on understanding how different individual objectives of policies addressing the same complex problem are consistent. Then, instruments are identified as a set to analyse policy coherence by studying how different policies can work together to achieve the overall objectives of the problems considered. Lastly, coherence among target populations is analysed based on how policies with the same objectives may let a target of the problem not addressed, identifying duplication or gaps in populations.

In multidimensional public problems, a common characteristic in policy mix context, coordination and coherence can be achieved but still exist different actors and instruments working individually for the same shared vision and only basing their actions by their own designs. This can generate difficulties to address complex problems and policy integration appears as, not only the sum of coordination and coherence but, a process of policies and organizations working by taking part of an overall strategy which is not defined specifically in the instruments and goals. In sum, policy integration is defined by Cejudo and Michel (2017) as the “*process of making strategic and administrative decisions aimed at solving a complex problem.*” Three levels of policy integration are identified by the authors and represented of figure 17 and, as the other concept levels, the higher level represents a more successful implementation of the concept. All things considered, it can be noted that policy integration, coherence and coordination are related, not synonyms, and are processes, not results.

Addressing the coherence in public policy decision-making, Nilsson and Weitz (2019) suggest a framework based in three-stage model: “(1) *understanding policy interactions (input)*, (2) *integrating policy-making (process)*, and (3) *assessing ex ante policy decisions (output)*”(Nilsson & Weitz, 2019).

	Coordination	Policy coherence	Policy integration
Object	Organizations	Design of each policy within a policy area	Decision-making processes regarding a set of agencies and policies
Definition	A process in which members of different organizations define tasks, allocate responsibilities, and share information in order to be more efficient when implementing the policies and programs they select to solve public problems	The process where policy makers design a set of policies in a way that, if properly implemented, they can potentially achieve a larger goal	The process of making strategic and administrative decisions aimed at solving a complex problem. Solving this complex problem is a goal that encompasses—but exceeds—the programs' and agencies' individual goals
Attributes	Information sharing Clearly defined rules and responsibilities	Policies' goals Policies' instruments Policies' target populations	A decision-making body in charge of addressing a complex problem. Capacity (authority and information) for deciding over instruments needed for addressing a complex problem
Scale	Level 1: regular exchange of information between members' organizations for achieving their own goals more efficiently Level 2: formal information exchange with which members' organizations make decisions regarding their own resources, and work individually, to contribute to a shared goal Level 3: formal information exchange with which members' organizations make joint decisions regarding the existent resources for achieving a shared goal	Level 1: policies could simultaneously operate without getting in each others' way, but without contributing in a clear and differentiated manner to solve the same complex problem Level 2: policies complement each other, and could contribute to address the complex problem Level 3: policies complement each other in order to address the complex problem, and they would be enough to do it comprehensively	Level 1: the decision-making body's capacity is limited to modify operational and design aspects of the instruments (programs and agencies) of the overall strategy Level 2: the decision-making body has the capacity to redefine the design, modify the operation, and reallocate the responsibilities and resources that the agencies and programs already have Level 3: the decision-making body has the capacity to use and modify the existent instruments (programs and agencies), and also to create new ones or eliminate them
Questions	Is there a shared goal among organizations? Do organizations establish rules and define responsibilities for coordination? Do organizations share information?	Do these policies overlap? Do these policies reinforce each other? Do these policies serve the same overarching goal? Are these policies enough to achieve the larger goal (that of the policy domain)?	Is there a mandate to address a complex problem and a causal theory for doing so that involves several organizations and policies? Is there a decision-making body responsible for addressing a complex problem? Does the decision-making body have the authority for modifying the programs, agencies, financial and human resources in order to contribute to solve the complex problem? Does the decision-making body have the necessary information to guide its decisions about the programs, agencies, financial, and human resources for contributing to solve the complex problem?

Figure 17 Objects, definition, attributes, scale and questions for Coordination, Policy Coherence and Policy Integration. Source: (Cejudo & Michel, 2017)

2.5. ENERGY POVERTY

2.5.1. DEFINITION

Two types of dimensions appear when understanding Energy Poverty definition (table 12). First, (1) **facilities** have an important part defining how consumers can spend energy in their needs such as cooking, warming or colling their homes, and, second, (2) **capabilities** focus on the ability of consumers to access the energy, making this point often related to financing (Siksnyte-Butkiene et al., 2021; Yearwood & Pye, 2016).

Table 12 Energy Poverty Definitions

Energy Poverty	(Kyprianou et al., 2019)	<i>"Inability to attain a socially and materially necessitated level of domestic energy services."</i>
	(European Commission, 2020b)	<i>"Energy poverty is a situation in which households are unable to access essential energy services"</i>
	(EPOV, 2021b)	<i>"Energy poverty is a distinct form of poverty associated with a range of adverse consequences for people's health and wellbeing – with respiratory and cardiac illnesses, and mental health, exacerbated due to low temperatures and stress associated with unaffordable energy bills."</i>
	(Dobbins et al., 2019)	<i>"A situation where households are unable to adequately meet their energy needs at an affordable cost. It is caused by a combination of inter-related factors including low income, high energy prices, poorly insulated buildings, inefficient technologies and sometimes limited access to clean and affordable energy sources"</i>
	(European Cooperation in Science and Technology, 2019)	<i>"Commonly understood as a household's inability to secure socially- and materially-necessitated levels of energy services in the home"</i>
	(Bouzarovski, 2017)	<i>"A household is unable to secure a level and quality of domestic energy services—space cooling and heating, cooking, appliances, information technology—sufficient for its social and material needs"</i>
	(Ürge-Vorsatz & Tirado Herrero,	<i>"Broader concept encompassing the various sorts of affordability-related challenges of the provision of adequate energy services to</i>

2012) the domestic space.

In figure 18, three main areas and their combination are identified as factors contributing to Energy Poverty. These factors and indicators will be further discussed in its respective segments.

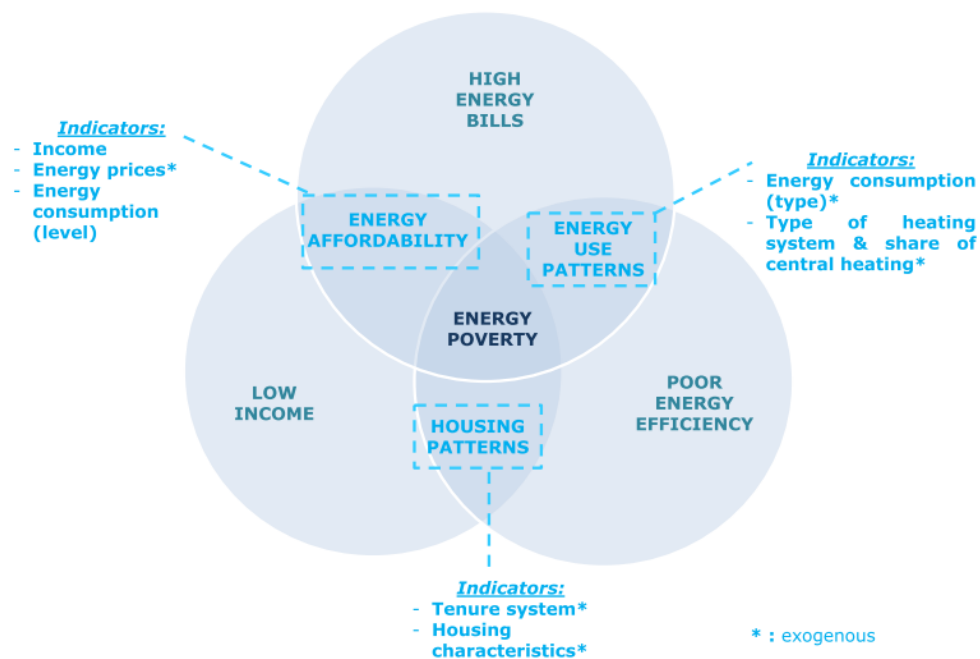


Figure 18 Three major Factors on Energy Poverty and key indicators. Source: (Pye et al., 2015)

2.5.2. EUROPE CONTEXTUALIZATION: DATA, POLICIES, AND INITIATIVES

According to Energy Poverty Observatory (EPOV), 50 million households are experiencing energy poverty (EPOV, 2021b) and, in a more recent report published in 2020 by EPOV, when considering the expenditure-based indicators, 82.3 million households are noted in an intensified situation of energy poverty in EU. In figure 19, vulnerability to energy poverty across EU member states in 2016 is represented, highlighting Greece, Bulgaria, Italy, Portugal, and Cyprus as the top 5 member states with higher risk of poverty to keep their home adequacy warm.



Figure 19 Risk of poverty with an inability to keep their home adequately warm across EU in 2016. Source: (Dobbins et al., 2019)

In 2009, European Commission addressed for the first time Energy Poverty (EP) with the Directives 2009/72/EC and 2009/73/EC which ordered the development of national action plans or other frameworks to deal with Energy Poverty issue (Gouveia et al., 2019). Thus, when considering the key junctures, EP is mentioned further back in time under other concepts such as fuel poverty, energy efficiency and energy justice. Kyprianou et al. (2019) studies EP policies and measures in 5 EU countries and, after assessing the complex nature of EP and the difficulties to identify EP consumers, define a timeline of main policies in EU on the topic of EP (figure 20).

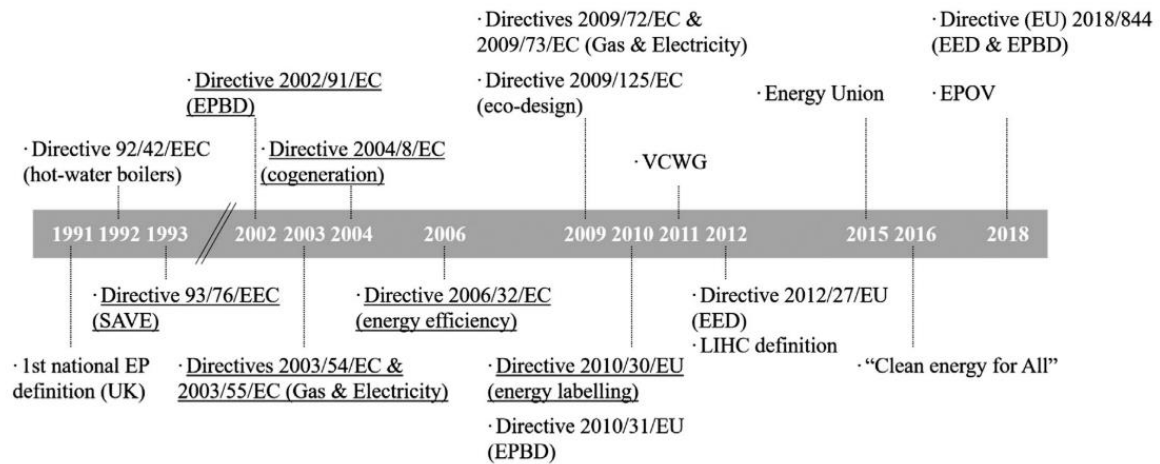


Figure 20 Timeline of EU main policies on the topic of EP. Source: (Kyprianou et al., 2019)

The Clean Energy for All European Package (CEP) was the generator of EPOV, an European initiative to achieve the objectives of the package on changing and integrating EP in policies across EU (Dobbins et al., 2019; Kyprianou et al., 2019). Through EPOV and ENGAGER, a research network funded by European Cooperation in Science and Technology (COST), information is shared to fill key research gaps, finding indicators to measure and develop EP issues in different context and taking consideration different stakeholders (Dobbins et al., 2019). These European initiatives show the EU interest accessing energy poverty but as previously mentioned, difficulties appear when defining energy poverty and its vulnerable consumers, and national policies are an important factor on assessing these issues.

On EPOV website indicators, data to approach and measure the issue can be consulted (EPOV, 2021b). On its Guidance for Policymaking (EPOV, 2021a), four points are considered essential to address EP in policies: (1) **Measurement**; (2) **Definition**; (3) **Policy Type**; and (4) **Financing and Funding**. While working closely with relevant stakeholders, such as Covenant of Mayors (Covenant of Mayors, 2021), and through the information and data collected, EPOV combats the key gaps and makes it easier to develop research and urban policies under the topic (Bouzarovski & Thomson, 2020).

When it comes to energy poverty definition, EPOV defines it as *“a distinct form of poverty associated with a range of adverse consequences for people’s health and wellbeing – with respiratory and cardiac illnesses, and mental health, exacerbated due to low temperatures and stress associated with unaffordable energy bills”* but there is no standard definition on energy poverty and authors have studied the evolution of the concept and different ways to approach the issue. (European Commission, 2020b; Siksnelyte-Butkiene et al., 2021). However, it can be noted that the EPOV definition of Energy Poverty especially focus on the health effects and well-being of the issue.

2.5.3. VULNERABLE CONSUMERS AND ENERGY POOR: DIFFERENCES AND DEFINITION

Defining the population group considered energy poor is an important step to access Energy Poverty. Although some policy-makers view energy poverty as a phenomenon in low income households, the problem goes further than that, finding mid-to-high income households considered energy poor (Yearwood & Pye, 2016). Different authors (Kyprianou et al., 2019; Pye et al., 2015) analyse how European countries define those vulnerable consumers. Kyprianou et al. (2019), consider four criteria (individual characteristics, specific circumstances, social welfare system and related to energy consumption with contract limitations) and Pye et al. (2015) consider five categories (energy affordability, receipt of social welfare, disability/health, range of socio-economic groups and not available)⁶ of vulnerable consumers definitions. The income is the most focused driver considered in the definition in both studies, being used in total by 14 EU member states. However, as previously mentioned, energy poor consumers are not only a consequence of low income since other drivers take an important action on defining these consumers.

In sum, socio-economic group, housing situation, energy use and demographic situation are the general parameters used to identify the targets on energy poverty policies. Additionally, to define the vulnerable consumers as a step of definition of energy poverty and ability to choose indicators, its is important to distinguish vulnerable consumers and energy poverty and understand how these are not synonyms and are being currently used for different objectives in the literature. On table 13, these two concepts are distinguish taking in consideration the energy sources, timeframe, target groups and implementing agent.

Table 13 Vulnerable Consumers vs Energy Poverty. Source: adapted from (Dobbins et al., 2019)

	Vulnerable consumers	Energy poverty
Concept	Includes individuals in energy poverty and those at risk, but also a broader group of specific consumers such as recipients of social welfare or those with disability and/or health issues who may be at a disadvantage in the purchasing and use of energy	Commonly understood to describe a situation where individuals or households are not able to adequately heat or purchase other energy services at an affordable price
Energy	Focus on electricity and gas, based on	All household energy sources,

⁶ When comparing the criteria and categories used while analysing the definition of vulnerable consumers, it is possible to comprehend that the last case one only differs on adding the situation where the concept is not mentioned- not available category. This is justified since Kyprianou et al. (2019) only analyse five countries, all defining vulnerable consumers, and Pye et al. (2015) analyse the EU 28 member states at the time.

Sources	legislative requirements (for example, internal energy market directives)	possibly including for mobility
Timeframe	Shorter-term curative focus on consumer protection and continued access to gas and electricity	Longer-term focus on prevention and addressing the underlying causes, such as poor building efficiency, low incomes and high energy costs
Target group(s)	Specific disadvantaged groups, such as those that receive social welfare or have health and/or disability issues	Lower income households facing energy affordability issues
Implementing agent	Typically the regulator or consumer protection agencies, utilities and government	A broader range of stakeholders such as government, consumer groups and non-governmental organizations, not just regulators and utilities households

2.5.4. ENERGY POVERTY DRIVERS, FACTORS AND OUTCOMES

The drivers of Energy Poverty will be addressed to understand the parameters used to define the targets in policies (table 14).

Several authors (Gouveia et al., 2019; Primc & Slabe-Erker, 2020; Yearwood & Pye, 2016) state the importance of collecting the drivers to understand EP and the selection of indicators to policy-making. Yearwood and Pye (2016) consider six type of drivers: (1) structural, (2) Markets, (3) natural systems, (4) macro-economy, (5) economic and (6) policy (table 14). The main drivers identified by Gouveia and Simoes (2019) are energy inefficient housing stock, elderly household occupants, low household income and high energy price, falling specially under the economic driver identified by Yearwood and Pye (2016). However, the former authors note that EP is also an issue of health, energy, social services and housing and this is an important concern to policymakers to consider.

Table 14 Drivers of Energy Poverty. Source: adapted from (Yearwood & Pye, 2016)

Structural	Socio-political systems	Influence of energy market development, institutional structures, heating infrastructures, dwelling stock and tenure, and energy supply
Market	Market Systems	Influence of energy service tariffs or products and the type of assistance with energy affordability Example: regulated prices vs social tariffs
Natural systems	Climate	Determines energy demand. Influences the efficiency of the buildings and temperature systems type
Macro-economy	State of the economy	Influence the income.
Economic	Income	Influence the energy service provision, tenure of a household, dwelling size and quality of a building.
Policy	Policy framework	Influence the targets considered as vulnerable consumers and/or energy poor, the types of interventions.

Example: different type of policies access different categories.

The influence of energy poverty on health is mentioned through various publications. A study , relating health, well-being and EP, highlights the higher incidence of poor physical and mental health amongst the energy poor populations, when compared to the non-energy poor, and the largest disparities encountered between energy poor and non-energy poor households are within relatively equal societies (Thomson et al., 2017). A book accessing different topics on energy poverty, discuss energy as a human right and explain how the inability to modern energy and facilities can force households to use open fires as a warming method whose fumes and smoke are estimated to 1.3 million deaths per year, predominantly women and children. This is not only a symptom of a health issue but also gender discrimination since women suffer the consequences of inadequate energy access, the author argues (Bouzarovski, 2017).

Moreover, while designing a conceptual map of EP (figure 22), in addition to drivers, factors, outcomes and household energy systems are considered as features. First, household energy system considers the energy service demand, energy use and expenditure. Second, factors are categorised in physical infrastructure, policy interventions and demographics. Lastly, outcomes are the results from energy poverty which can be “*indebtedness, disconnection, health impacts, social stigma and mental well-being*”. These features do not work independently but the interaction between each other are the representing map to understand EP. For instance, the outcome of indebt can be a result from the inefficiency of the building which demands a high energy consume and is previously influenced by the low income of household, consequently depending on the state of economy, location and demographic of the household. In this example, different drivers, factors and household energy system can be attributed to the outcome of the situation (Yearwood & Pye, 2016).

Policies are an important factor on energy poverty definition, measuring, monitoring and a step to battle the issue. Yearwood and Pye (2016) propose categorising policy interventions in (1) short term financial interventions, (2) additional consumer protections specifically targeted at vulnerable consumers, (3) energy efficiency measures targeting structural EP problems and (4) improved consumer awareness and information. Kyprianou et al. (2019) follow the same type of boundaries, identifying four types of measures used in Europe to tackle EP (figure 21).

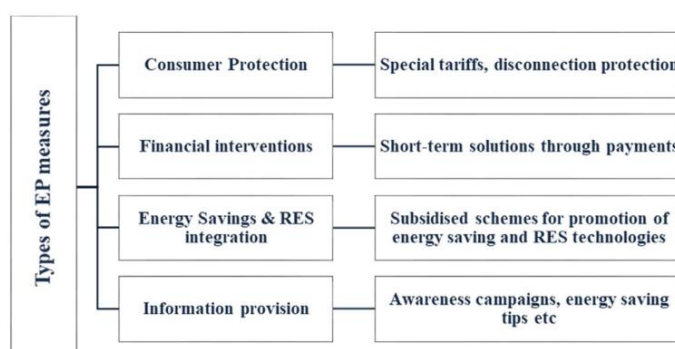


Figure 21 Types of Energy Poverty measures in Europe. Source: (Kyprianou et al., 2019)

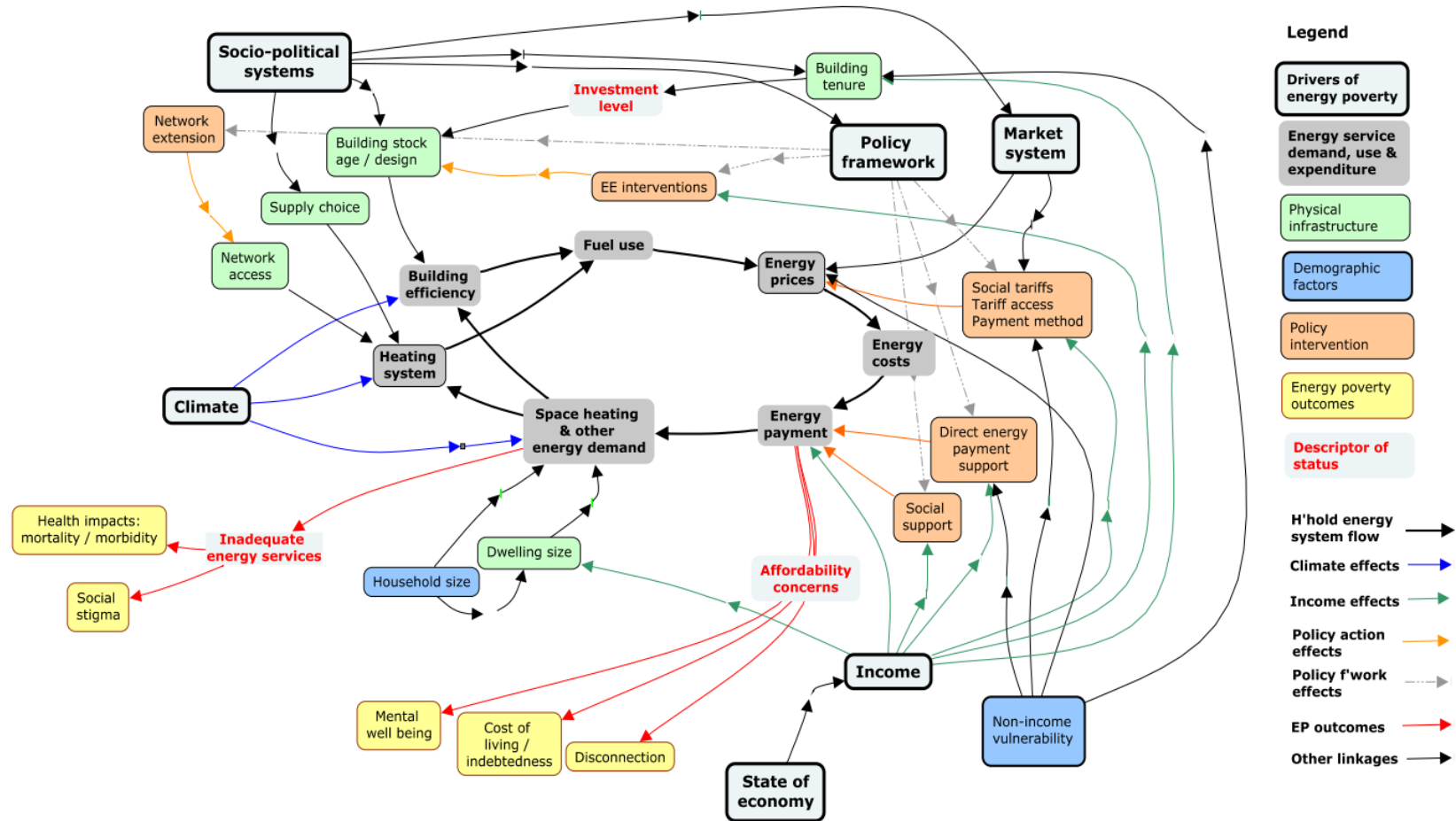


Figure 22 Conceptual Map of the drivers, causes and effects of Energy Poverty. Source: (Yearwood & Pye, 2016)

2.5.5. INDICATORS

Following the guidance for policy making by EPOV, selecting indicators is an important part to measure and monitoring energy poverty. EPOV identifies three different types of indicators: (1) energy costs and income, (2) self-assessment, (3) direct measurement and (4) proxy indicators (EPOV, 2021a), figure 23.

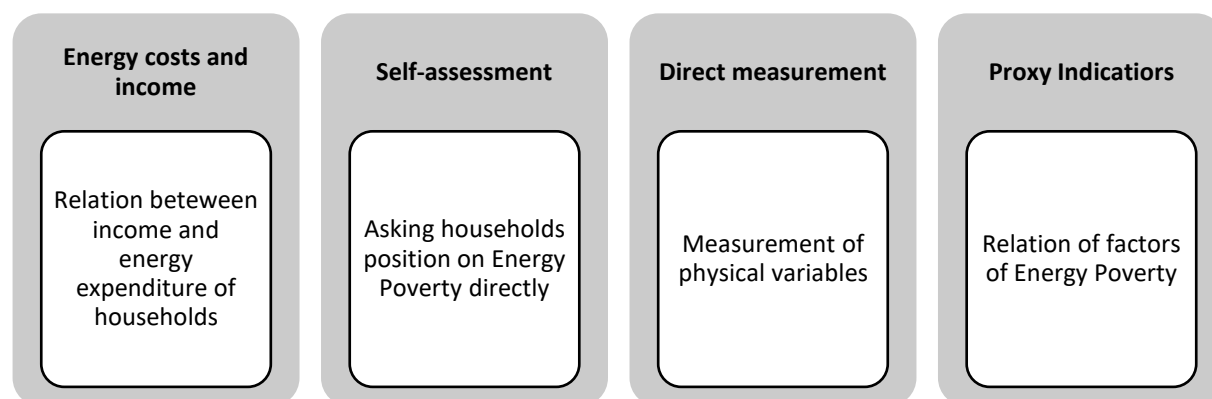


Figure 23 Types of indicators according to EPOV

As have been previously mentioned, measurement is the major challenge of EP and is related to limitations of databases and the indicators used. This can result in lack of representation of the energy issues and the targets selected to reduce energy poverty problems (Sareen et al., 2020). On a report published in 2019 by EPOV, indicator gaps are presented under the prevalence of EP in EU. The gaps presented are (1) electrical safety relation to EP, (2) impact of poor energy supply in economy, (3) updated air cooling indicators, (4) health and well-being indicators focused on individual conditions, (5) data on energy services in the home, (6) regionally specific and targeted data and (7) household needs and practices data (Thomson & Bouzarovski, 2019).

In a report made for European Commission, 178 indicators were assessed to understand the overview of measuring and monitoring EP. All the indicators were selected from EU data, such as EU Building Stock Observatory ⁷, EUROSTAT⁸, SILC⁹ and EU projects and the percentage of different indicators categories were summarised in (figure 24).

⁷ https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/eu-bso_en Retrieved April 11, 2021

⁸ <https://ec.europa.eu/eurostat> Retrieved April 11, 2021

⁹ <https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions> Retrieved April 11, 2021

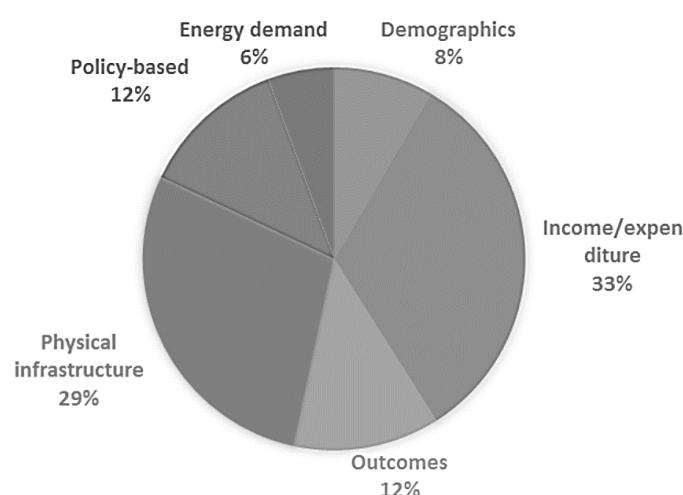


Figure 24 Categories of indicators accessed. Source: adapted from (Yearwood & Pye, 2016)

After analysing the 178 indicators through a matrix with several criteria based on the information collected by the authors, testing and validation of the energy poverty metrics, four indicators of EP are suggested (table 15): (1) 2M, (2) LHIC, (3) HEP M/2 Exp and (4) Warmth (Yearwood & Pye, 2016).

Table 15 Energy Poverty Indicators suggested by Yearwood and Pye (2016): description, notes and data requirements

Indicator	Description	Notes	Data requirements
2M	Share of expenditure compared to equivalized disposable income above twice the national median	Considers country-specific pattern	Household Budget Surveys(HBS): -Equivalized income -Taxes -Energy expenditures
LHIC	<i>Low Income High Cost</i> Energy expenditures are above the median level and if they spend this amount, their residual income is below poverty line	-Distinguish EP from generalized poverty -Relates EP with income	
HEP M/2 Exp	<i>Hidden Energy Poverty</i> Absolute energy expenditure below half the national median	-Critical on low expenditure -Crucial on actual expenditure	
Warmth	Inability to keep the house warm	-Only considers warming services	SILC

Withstanding with the previous sources of data considered by Yearwood and Pye (2016), EPOV categorise 2M, M/2 and inability to keep the house warm as primary EP indicators. Although, LHIC is not mentioned instead, the indicator of (sub-) population having *arrears on utility bill* based on question "In the last twelve months, has the household been in arrears, i.e. has been unable to pay on time due to financial difficulties for utility bills (heating, electricity, gas, water, etc.) for the main dwelling?" is considered. Lastly, secondary indicators are those which are relevant in context of EP

but not directly represent it. Both types of indicators are represented on table 16 (Thema & Vondung, 2020).

Table 16 Primary and Secondary Indicators by EPOV, last updated in January 2020

Primary Indicators	• Arrears on utility bills • M/2 (Share of households whose absolute energy expenditure is below half the national median.) • 2M • Inability to keep home adequately warm
Secondary Indicators	• <i>Prices</i> of: fuel oil, biomass, coal, household electricity, district heating and household gas • <i>Dwellings</i>: comfortably cool or warm during summer or winter time, in densely or intermediately populated areas, with energy label A • Number of rooms per person, owners • Poverty Risk • <i>Energy expenses</i>: income quintiles • -Equipped with air conditioning/heating • Excess winter mortality/deaths • Presence of leak, damp, rot

Meanwhile, in a recent published study, EP indicators are reviewed through a systematic literature search and analysis based on SALSA framework and PRISMA statement to ensure “*consistency and completeness of research*”. The approach is considered as PSALSAR, meaning six main steps (Protocol, Search, Appraisal, Synthesis, Analysis and Report) table 17 (Siksnyte-Butkiene et al., 2021).

Table 17 PSALSAR framework of literature search and review to Energy Poverty Indicators. Source: adapted from (Siksnyte-Butkiene et al., 2021)

Steps	Main Tasks and Methods
Protocol	Study scope: Indicators and composite indicators for evaluating EP <i>Method</i> : PICOC framework
Search	Search databases on keywords identified
Appraisal	Studies selection <i>Method</i> : Flow of information through the PRISMA statement (identification, screening, eligibility, and included papers) Snowballing technique
Synthesis	Preparation of template for data extraction Categorization of data for further analysis <i>Method</i> : The PRISMA statement comprising a 27-item checklist
Analysis	Analysis of organized data according to selected categories Comparison of data results Obtaining conclusions and recommendations
Report	Summarization of results for public in an article form <i>Method</i> : The PRISMA statement 27-item checklist

Considering the EP measurement, 519 studies were screened, 150 were applied the exclusion criteria and 71 were further analysed and evaluated- *Protocol* and *Search* steps. Then, the data was extracted from studies based on a checklist of items (year of publication, journal, case study location, application area, aim of study, methodology, and indicators used) and classified in two categories of EP indicators, general and specific-*Synthesis* step. Lastly, indicators are presented based on their main objectives (figure 25)- *Analysis* step.

During the PSALSAR framework, it is noted the relevance of EP topic and seeking for a universal definition and analysis of its indicators since between 2018 and 2020 60 percent of the studies by the authors to further analysis and evaluation were reported. The author add that even if energy poverty can be assessed through other terms, as previously discussed in this dissertation, ‘energy poverty’+ ‘indicators’ keywords set was the one with bigger number of indicators presented (Siksnyte-Butkiene et al., 2021).

Application areas	Methodology used	Groups of indicators	Location	Year of publication
- Household - Energy policy - Enterprises	- Multi-criteria decision-making tools - Regression analysis - Logistic analysis - Mathematical analysis - Comparative analysis - Construction of indices - LCA - Experts survey - Questionnaire - Multiple linear regression - Artificial neural networks - Scenario construction - Uncertainty and sensitivity analysis	- Efficiency - Income - Habits - Economic - Social - Institutional - Energy prices - Type of energy - Energy consumption - Energy import/export	- Europe: Greece, Italy, United Kingdom, France, Cyprus, Portugal, Canary Islands, Poland, Spain, Czech Republic, Germany, Ireland, Ukraine, Hungary, Belgium - Asia: China, Philippines, Japan, Thailand, Indonesia, Cambodia, India, Nepal - South America: Mexico, Brazilia, Chile - Africa: Ghana, Nigeria, Kenya, Ecuador - Australia - Multiple countries, European Union (EU), South Africa region, 7 Latin America countries	2012 (3) 2013 (4) 2014 (3) 2015 (7) 2016 (4) 2017 (4) 2018 (14) 2019 (17) 2020 (15)

Figure 25 Classification of studies accessing Energy Poverty Indicators. Source: (Siksnyte-Butkiene et al., 2021)

Following the Bellagio sustainability assessment and measurement principles (STAMP), EP indicators were evaluated from 1 to 12 points, based on 12 parameters organised in three sub criteria to each major criteria (tables 18 and 19). The rates of the indicators resulted in the interval of 5 and 11 points. Furthermore, it is noted that all developed indicators systems are usually economic, in contrast to the literature analysed, environmental dimension to measure EP is presented in very few indices and that *Structural EP Vulnerability Index* and *Fuel Poverty Index* are the top-rated indices.

Table 18 Criterion and Sub criteria to evaluate Energy Poverty Indicators. Source: adapted from (Siksnyte-Butkiene et al., 2021)

Criterion	Sub criteria		Notion	
	Title			
Objectivity	1 Indicators reflecting economic dimensions of the problem are involved		O	1
	2 Indicators reflecting social dimensions of the problem are involved			2
	3 Indicators reflecting environmental dimensions of the problem are involved			3
Transparency	4 Methodology for indicator selection is presented		T	1
	5 Links to data sources are clearly indicated	6		2
	6 Data sources are publicly available			3
Practicability and Flexibility	7 A system for indicator calculation is quite simple		PF	1
	8 The indicators set can be easily adapted to other research			2
	9 The methodology for calculation is presented (or links provided)			3
Participation	10 Stakeholders or experts are involved in the process of selection of indicators		P	1
	11 Stakeholders or experts are involved in the determination of weights of the indicators			2
	12 Scientific methods are used for stakeholders or expert participation (selection, concordance of opinions)			3

Table 19 Indicator or set of indicators evaluated for Energy Poverty Assessment. Source: adapted from (Siksnyte-Butkiene et al., 2021)

Indicator (set)	Criteria												#
	O			T			PF			P			
	1	2	3	1	2	3	1	2	3	1	2	3	
HIGH compliance with the STAMP													
Structural EP Vulnerability Index	x	x		x	x	x	x	x	x	x	x	x	1
Fuel Poverty Index	x	x		x	x	x	x	x	x	x	x	x	1
Energy Vulnerability Composite Index	x	x		x	x		x	x	x		x	x	9
Medium compliance with the STAMP													
Single indicators (10 %, 2 M, MIS, LIHC, AFCEP)	x			x	x	x	x	x	x	x			8
EU-SILC	x	x			x	x	x	x	x	x			8
EP index	x	x		x	x	x	x	x	x				8
Multi-dimensional EP Index	x	x		x	x	x	x	x	x				8
Indicator	x	x		x	x	x	x	x	x				8
Comprehensive Energy Poverty Evaluation Index	x	x	x	x	x	x		x	x				8
Energy Poverty Index	x			x	x	x	x	x	x		x		8
Multi-dimensional Energy Poverty Index	x	x		x	x	x	x	x	x				8
Multi-dimensional EP index (index comprising 5 indicators)	x			x	x	x	x	x	x				7
Multidimensional EP Index (I)	x			x	x	x	x	x	x				7
Multidimensional EP Index (II)	x			x	x	x	x	x	x				7
Index of Vulnerable Homes	x	x		x	x		x	x	x				7
EP Vulnerability Index	x	x		x	x			x	x		x		7
Compound EP Indicator	x			x	x	x	x	x	x				7
Indicator Karasek and Pojar	x			x	x	x	x	x	x				7

Atkinson Index	x		x	x	x	x	x	x	7
Composite Vulnerability Indicator	x	x		x	x	x		x	7
Comprehensive Energy Poverty Index	x		x	x	x	x	x	x	7
Energy Development Index	x		x	x	x	x	x	x	7
Compound Energy Poverty Indicator	x		x	x	x	x	x	x	7
Global Energy Vulnerability Index	x		x	x	x	x		x	7
Multi-Tier Framework	x	x	x	x	x			x	7
Low compliance with the STAMP									
A multi-source framework for identifying energy poor households	x		x	x		x	x	x	6
Hidden EP indicator	x		x	x		x	x	x	6
Fuel Poverty Index	x		x	x		x	x	x	6
Fuel Poverty Index (FPI)	x		x		x	x	x	x	6
Energy Access Index	x		x	x		x	x	x	6
The Building Fuel Poverty index	x		x	x	x	x		x	6
Composite Electrical Energy Poverty Index	x		x	x		x	x	x	6
Stochastic Model of EP	x		x	x			x	x	5
Energy Access Index	x			x	x		x	x	5
Fuel Poverty Potential Risk Index	x	x		x	x			x	5

Taking into consideration that the process of measuring EP suffers from the multi-dimension and contextualization nature of EP problem, authors present the levels of assessment of measuring EP: macro, meso and micro (table 20). Additionally, three requirements are suggested to select a set of indicators for measuring EP:

“First, it is necessary to ensure that the set of indicators that has been formed fully reflects the modern concept of EP, that is, ensure that it includes not only the economic but also other dimensions of sustainable development. Second, depending on the countries or groups of countries that are being evaluated, the indicators must be selected and adapted considering the characteristics of the country under evaluation. Engaging experts, who can be involved in both the selection and weighting of indicators for developing indices, in the research is a scientifically acceptable way for this purpose. Third, reasonable and reliable methods provide the rationale and accuracy for evaluation.”

Table 20 Levels and dimensions of Energy Poverty Assessment. Source: adapted from (Siksnielyte-Butkiene et al., 2021)

Level of assessment	Economic dimension	Social dimension	Environmental dimension
Macro	-Competitive energy prices	-Socio-economic and demographic household characteristics	-Energy efficiency
	-Energy consumption	-Health	-Renewable Energy
	-Energy dependence	-Social policy actions	-Greenhouse gas emissions
	-Energy balances		

	-Policy actions		-Environmental, energy policy actions
Meso	-Competitive energy prices -Energy expenditure -Presence or absence of political actions/ initiatives	-Socio-economic and demographic characteristics -Health	-Energy efficiency of technologies used -Renewable fraction -Greenhouse gas emissions
Micro	-Energy access -Energy consumption (expenditure) -Energy prices Income	-Socio-economic and demographic characteristics -Health -Habits	-Housing characteristics -Energy efficiency of technologies used -Renewable fraction

Besides the already mentioned studies, other authors highlight the importance of selecting EP metrology to assess the EP problem (Kyprianou et al., 2019; Palma, 2017; Sareen et al., 2020). Sareen et al. (2020) propose an iterative framework with five dimensions (historical trajectories, data flattening, contextualised identification, new representation, and policy uptake) to analyse energy poverty metrology and discuss the importance of policy uptake to push a change in domestic energy deprivation. Palma (2017) develops the mapping of thermal comfort in residential dwellings needs in Portugal by assessing the gap of bottom-up buildings typology approach and a top-down energy use statistics-based approach. Kyprianou et al. 2019 analyse the EP policies and measures in 5 countries, presenting six indicators (Arrears on utility bills, Hidden EP (HEP), Inability to keep home adequately warm, High share of energy cost in income (2 M), Home uncomfortably hot in summer and Presence of leak, damp or rot).

Gouveia et al. (2019) propose Energy Poverty Vulnerability Index (EPVI) which focus “*on space heating and cooling, to map energy poor regions and identify hotspots for local action*” and tests the method in 3092 civil parishes in Portugal. The EPVI combines, socio- economic indicators of with climate variables, energy consumption levels, calculated energy demand for space heating and cooling, climatization technologies details and construction characteristics of several building typologies. The authors also propose three categories of EP measures taking in consideration the indicators based on (1) **expenditure** (e.g. LIHC), (2) **consensual approaches** (e.g. EU-SILC) and (3) **energy needs calculation** (e.g. DECC) (Gouveia et al., 2019).

In conclusion, indicators are being developed and analysed to assess Energy Poverty. The selection of the indicators is an important step to design policies since it reflects the contextualization of the problematic. Moreover, indicators also reflect the different dimensions being considered to define Energy Poverty: income, energy efficiency and energy consumption.

2.6. FINAL CONSIDERATIONS

The framework for literature selection adopted permitted to identify the relation of Policy Mix and Policy Coherence in the current debate of climate change and its mitigation and the sustainable transitions prevalently mentioned by OECD and European Union. In addition, Energy Poverty is an issue which has been gaining more relevance in the last years because of its relationship with energy policies and, consequently, its intrinsic connection with sustainable transitions and climate change mitigation.

In the literature selection, there are two different steps to achieve the literature review. At the **Brainstorm and Free search**, a natural and instinctive methodology is adopted to understand the existent literature on articulation of instruments for urban policies and the existing tools to help chain the next step. The **Systematic search** is developed as the combination of four different software (Mendeley, VOSviewer and Harzing's Publish and Perish) and the continuous use of the diary notebook and Excel. The goal of this step is using the current bibliometric analysis tools to better find quality and connection of the literature used.

Different **Policy Mix** Analysis methods are being considered in different policy fields. As Rogge et al. (2017) noted, three different fields - Economy, Innovation studies, and policy sciences- have been the key foundation to define Policy Mix. The table 21 overviews and summarise how Policy Mix is being covered in the three different fields. However, there is not a convergence on its definition and an interdisciplinary dialogue is difficult. For this reason, it was possible to understand that Policy Mix does not have a universal accepted definition and there is not a common framework for its analysis, too.

Nevertheless, after the selection of different literature it was possible to understand that policy process, elements and characteristics blocks are being considered by different authors to define Policy Mix - figure 26. Furthermore, different analysis are reviewed in aim to understand the common traits between them. Overall, the Policy Mix analysis presented start by understanding the complexity of the subject, defining the elements which will be assessed and, then, an iterative process is applied using criteria to evaluate the Policy Mix.

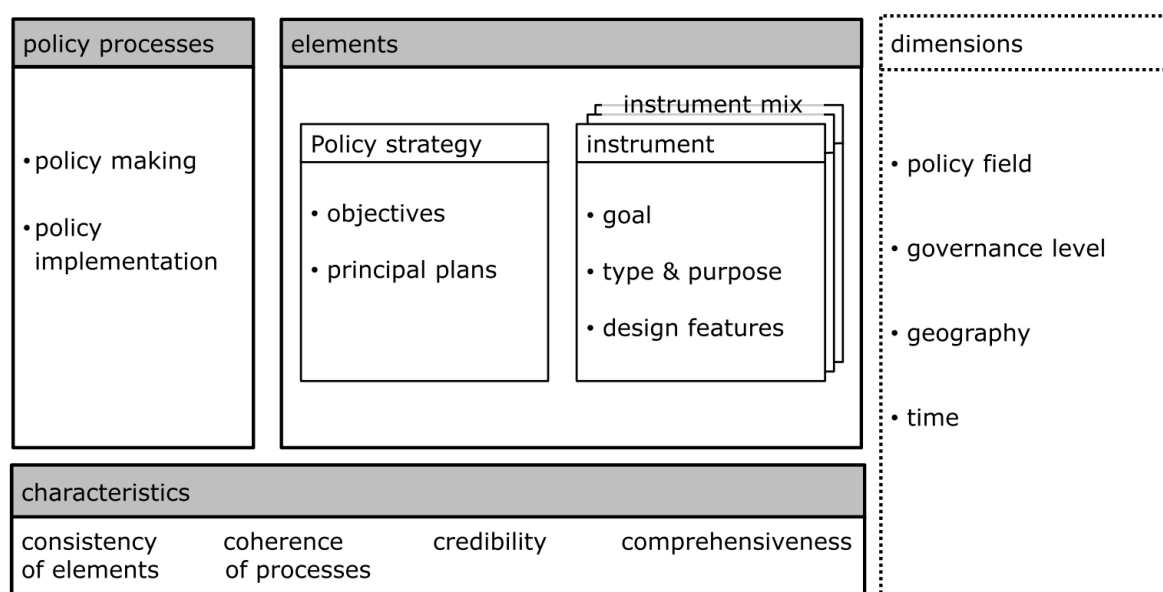


Figure 26 Policy Mix Blocks. Source: (Rogge & Reichardt, 2016)

Policy Coherence appears more related to the environmental field, with the policy sciences and its application in urban problematics. This is especially supported by the strong discourse of OECD on Policy Coherence for Sustainable Development which is backed by various publications and activities (OECD, 2017, 2019, 2021c, 2021a).

Although Policy Coherence literature does not directly mention Policy Mix, there is a common structure when analysing the selected policies which, indirectly, consider the blocks of Policy Mix (Chan et al., 2021; Moure et al., 2021). This is also evidenced by the Policy Mix analysis, where Policy Coherence is used when understanding the instrument mix, policy process or policy process as a criteria to evaluate their study cases on Policy Mix (Mavrot et al., 2018; Rogge & Reichardt, 2016). Ultimately, integration and coordination are related both to Policy Mix and Policy Coherence and their definitions are presented to define the limits of each concept.

Furthermore, access to energy and environmental policies impact **Energy Poverty**. Therefore, Energy Poverty complexity, multi-dimension and multi-level are currently being considered. At a macro level, the dependencies of EP on the context of the targets are acknowledged and, at the national level of EU, Member States recognise of the difficulty to measure EP.

Table 21 Policy Mix conceptualizations from three different fields (Source: (Rogge et al., 2017) compilation of (Flanagan et al., 2011; Howlett & Rayner, 2013; Florian Kern & Howlett, 2009; Rogge & Reichardt, 2016; Sorrell et al., 2003))

	Environmental economics external interaction Climate Policy P_{c1} P_{c2} Environmental Policy P_{e1}, P_{e2}, P_{e3}, etc. Other policy areas P_{o1}, P_{o2}, P_{o3}, etc. internal interaction Source: Sorrell et al. (2003), p. 28, Fig. 4.1	Policy studies <table><tr><th rowspan="2">Goals</th><th colspan="2">Instruments</th></tr><tr><th>Consistent</th><th>Inconsistent</th></tr><tr><td>Coherent</td><td>Replacement (conscious effort made to recreate or fundamentally restructure policies through the replacement of old goals and means by new ones)</td><td>Conversion (New instrument mixes evolve while holding old goals constant)</td></tr><tr><td>Incoherent</td><td>Drift (New goals replace old ones without changing the instruments used to implement them)</td><td>Layering (New goals and instruments are added to old ones without abandoning previous ones)</td></tr></table> Source: Kern and Howlett (2009), p. 396, Table 1, supplemented with definitions from p. 395	Goals	Instruments		Consistent	Inconsistent	Coherent	Replacement (conscious effort made to recreate or fundamentally restructure policies through the replacement of old goals and means by new ones)	Conversion (New instrument mixes evolve while holding old goals constant)	Incoherent	Drift (New goals replace old ones without changing the instruments used to implement them)	Layering (New goals and instruments are added to old ones without abandoning previous ones)	Innovation Studies Dimensions in which interactions can occur Across: Policy space Governance space Geographical space Time Possible types of interaction Between: ‘different’ instruments targeting the same actor/group (within/across dimensions) ‘different’ instruments targeting different actors/ groups involved in the same process (within/across dimensions) ‘different’ instruments targeting different processes in a broader system (within/across dimensions) Between: ‘the same’ instruments (across different dimensions) Possible sources of tension between instruments in the policy mix Conflicts between: policy rationales policy goals implementation approaches Source: Flanagan et al. (2011), p. 709, Fig. 1				
Goals	Instruments																	
	Consistent	Inconsistent																
Coherent	Replacement (conscious effort made to recreate or fundamentally restructure policies through the replacement of old goals and means by new ones)	Conversion (New instrument mixes evolve while holding old goals constant)																
Incoherent	Drift (New goals replace old ones without changing the instruments used to implement them)	Layering (New goals and instruments are added to old ones without abandoning previous ones)																
Example 2	Is it a single- or multi-aspect environmental issue? Single-aspect Is it feasible to address environmental externality directly? Yes A first best optimum can – under certain assumptions – be reached by a single instrument. Are all assumptions (reasonably) valid in the current context? Yes Use of a single instrument could be preferable. Multi-aspect A first best optimum can not be reached by a single instrument. The optimal mix of instruments will depend on the specifics of the environmental issue and on the existence of any market failures. No One or more proxy instruments would have to be used. The assumptions include: - Well established property rights - Full information - Perfect foresight - No market-power No A second best optimum requires one instrument per market failure. The optimal mix of instruments will depend on the specifics of the environmental issue and on the market failures present. Would there still be anything to gain by applying a mix of instruments? Source: Simplified from Braathen (2007), p. 187, Fig. 1	<table><tr><th rowspan="2">Policy Focus</th><th colspan="3">Policy Content</th></tr><tr><th>High Level Abstraction</th><th>Programme Level Operationalization</th><th>Specific On-the-Ground Measures</th></tr><tr><td>Policy Ends or Aims</td><td>Goals What General Types of Ideas Govern Policy Development?</td><td>Objectives What Does Policy Formally Aim to Address?</td><td>Settings What are the Specific On-the-ground Requirements of Policy?</td></tr><tr><td>Policy Means or Tools</td><td>Instrument Logic What General Norms Guide Implementation Preferences?</td><td>Mechanisms What Specific Typoes of Instruments are Utilized?</td><td>Calibrations What are the Specific Ways in Which the Instrument is used?</td></tr></table> Source: Simplified from Howlett and Rayner (2013), p. 175, Table 1	Policy Focus	Policy Content			High Level Abstraction	Programme Level Operationalization	Specific On-the-Ground Measures	Policy Ends or Aims	Goals What General Types of Ideas Govern Policy Development?	Objectives What Does Policy Formally Aim to Address?	Settings What are the Specific On-the-ground Requirements of Policy?	Policy Means or Tools	Instrument Logic What General Norms Guide Implementation Preferences?	Mechanisms What Specific Typoes of Instruments are Utilized?	Calibrations What are the Specific Ways in Which the Instrument is used?	policy processes • policy making • policy implementation elements Policy strategy • objectives • principal plans instrument mix instrument • goal • type & purpose • design features characteristics consistency of elements coherence of processes credibility comprehensiveness dimensions • policy field • Governance level • geography • time Source: Rogge and Reichardt (2016), p. 1629, Fig. 2
Policy Focus	Policy Content																	
	High Level Abstraction	Programme Level Operationalization	Specific On-the-Ground Measures															
Policy Ends or Aims	Goals What General Types of Ideas Govern Policy Development?	Objectives What Does Policy Formally Aim to Address?	Settings What are the Specific On-the-ground Requirements of Policy?															
Policy Means or Tools	Instrument Logic What General Norms Guide Implementation Preferences?	Mechanisms What Specific Typoes of Instruments are Utilized?	Calibrations What are the Specific Ways in Which the Instrument is used?															

Different policies are being used to access Energy Poverty, such as social and energy policies, and there is a scientific recognition on how these policies affect the situations analysed. The (figure 27) represents the contributing factors and influence of policies to fuel poverty¹⁰ mitigation, a type of problem accessed under EP issues, representing the multitude of the Energy Poverty and the different drivers addressed.

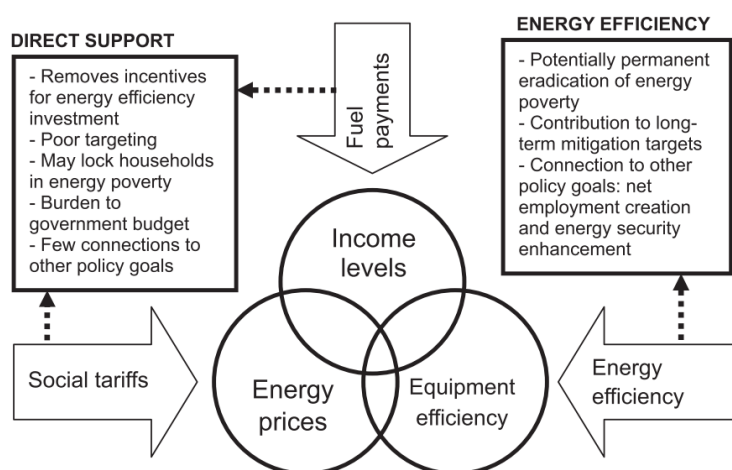


Figure 27 Fuel Poverty drivers - centre of the image-, Energy Efficiency and Policy contributions. Source: (Ürge-Vorsatz & Tirado Herrero, 2012)

As a result of understanding the different elements of **Energy Poverty** - measurement, definition, policy types considered, and indicators -, Policy Mix appears as a substantial concept to understand and analyse how the combat to energy poverty can be achieved (Bouzarovski, 2017). Thereupon, understanding the concept of Policy Mix, its definition and methodology to analyse different types of problems are essential when considering the context of the issue.

In conclusion, the current state of literature demonstrates how Energy Poverty, Policy Mix and Policy coherence are a recent topic on policy studies, R&D, sustainable transitions and climate change mitigation. The recognised complexity of the problems presently approached by urban policies has made a substantial point to clarify the definitions of the different concepts, selection of indicators and criteria to analyse, evaluate and measure in a way to monitor the success (or not) of implementation of policies and identification of problems to integrate the iterative process that these problems require.

¹⁰ Firstly, used in UK as an indicator of “inability of household to ensure adequate thermal regime in its living space”. When defining energy poverty, fuel poverty is sometimes used as synonym of energy poverty but recent literature already distinguish both concepts being EP considered a broader term which involves fuel poverty (Ürge-Vorsatz & Tirado Herrero, 2012)

3

POLICY MIX ANALYSIS FRAMEWORK

3.1. OBJECTIVES

Since Policy Mix and its analysis do not have a universal definition or methodology, all the framework was developed considering different information, patterns and convergences which were summarised from the different topics previously discussed in the Theoretical Background chapter. For this reason, the goals were defined based on literature and organised in different themes (table 22).

Table 22 Goals which justify the adopted methodology

Theme		Goal	Source
PF	Policy Mix Evaluation Framework	G1 Maximising the effectiveness or efficiency of on the complementarity of the instruments involved.	(Schröter-Schlaack et al., 2013)
		G2 Appropriate mix of instruments and actors.	
		G3 Consider Target Groups.	
IA	Interaction Analysis	G1 Focus on existing or proposed instruments, analyse two or more instruments, and finally aims to identify possible conflicts or synergies between these instruments	(Ring & Schlaack, 2011)
		G2 Comparing the scope of the instruments, the nature of the objectives, the timetable of the instruments, the operation of the instruments, and the process of	

			implementation	
C	Coordination	G1	Develop reinforcement mechanisms; address possible negative interactions.	
PA	Policy Mix Analysis	G1	Policy mix analysis does not primarily ask whether one instrument is more effective or efficient than another, assuming only the more effective instrument should be used. The interesting question for policy mix analysis is on interaction between instruments.	
K	Keyword for Analysis Process	G1	Policy Coherence	(OECD, 2007; Ring & Schlaack, 2011)
		G2	Positive/Negative Interactions	
		G3	Policy Context	

In summary, the framework aims to answer the following topics:

- **Policy Mix Evaluation Framework:** what are the different goals which should be considered when defining the methodology of the analysis?
- **Policy Mix Analysis:** what should be the intrinsic objective of it, *id est*, what is the focus of the analysis and its contribution to the Policy Mix topic?
- **Keywords for the Analysis Process, Interaction Analysis and Coordination:** the various criteria and support for the framework adopted in this work.

The literature on these three themes and their common characteristics should be applied during the assessment of the chosen instruments. Furthermore, while defining the goals, seven different questions are considered (table 23).

Table 23 Policy Mix Analysis questions

Theme		Questions		Source
PA	Policy Mix Analysis based on interactions	Q1	Are combinations of instruments complementary to each other?	(Ring & Schlaack, 2011)
		Q2	Are the instruments mutually reinforced?	
		Q3	Do the instruments involve conflicts when present at the same time?	

IA	Interaction Analysis	Q4	Are the instruments suitable to be introduced one after the other in a temporal relationship to increase outcome?
		Q1	How and why are two policies affecting each other?
		Q2	What are the consequences of the interaction for the target groups, and the organizations involved in implementing the instrument and aiming to achieve the policy objective?
		Q3	What is the evaluation of the desirability of the consequences of the instrument interaction against chosen evaluation criteria?

3.2. INSTRUMENTS SELECTION

The Instruments¹¹ should be selected based on the topic of assessment. The evaluators should consider the context of the analysis to define the goals and key factors to apply the framework which will affect the instruments selected for analysis. In this situation, it is important to define criteria to limit the number, the type of documents and what are the elements of the Policy Mix which will or not be covered.

There are different pathways for Policy Mix Analysis, and they are not discrete nor continuous. It is important to understand the specific context of Policy Mix to select which pathway will be followed and if it is necessary to combine and adapt different phases (figure 28) (Mulligan et al., 2017; Ring & Schlaack, 2011; Samset & Christensen, 2017).

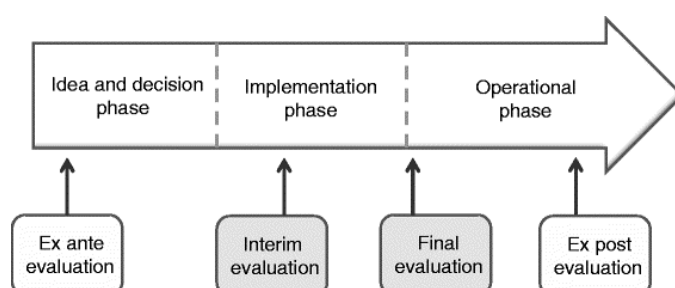


Figure 28 Policy Phases and its Pathway for Analysis adapted from (Samset & Christensen, 2017)

¹¹ The term instrument is used to aggregate policies, programs, initiatives and other elements that are studied under the Policy Mix topic. This term was selected based on its use of the literature previously reviewed.

In the **Ex Ante** case, the goal is to analyse how a new instrument will perform in the overall Policy Mix. In this case, the single instrument is not only analysed individually but also on the overall of the already present Policy Mix. This is when the analysis can possibly contribute to the course of the policy implementation. Furthermore, the interim evaluation occurs at the start of the implementation. In this case, Ex Ante analysis will help to manage and correct mistakes.

However, it is important to note that it is also possible to analyse how various instruments newly introduced can contribute to an already existent or a new Policy Mix. Policy Mix does not necessarily need to be already recognised but the elements which are already being developed or implemented can be analysed to understand how they do, or do not, contribute to a new topic. This is especially important to recognise since politics are currently rapidly changing and more and more instruments are being developed to answer complex issues which require coordination and integration between different policy fields.

In the **Ex Post** case, the outcomes of the Policy Mix are the evaluation focus. In this case, instruments are analysed based on how they achieved the policy goals and different criteria can be selected considering the context of the Policy Mix. The major aim of this evaluation is to understand the lessons from the Policy Mix implementation and operational phase.

The instruments used for analysis, in the Ex Post, already require information of the outcomes of the Policy Mix. Then, this is the greater difference between the Ex Ante and Ex Post analysis. And the instruments selected can define the pathway which, consequently, will relate to the objectives of analysis and influence the selection itself. Hence, the selection of instrument is an iterative process which considers the context of its application and requires the capacity to learn about the subject at the same time the goals, pathways and criteria are selected and adapted in the framework.

All things considered, the instruments selection should contemplate and can influence the objectives of the analysis. This iterative process requires understanding the dimensions and interactions which will be considered and how the instruments selected can provide sufficient information to support the application of the criteria for evaluation. The policy field contextualization is what generates the structure to choose the pathway to consider.

3.3. SINGLE INSTRUMENT ANALYSIS

The Single Instrument Analysis will depend on the pathway selected for analysis. As has already been explained, **Ex ante** analysis considers the application of a new instrument to the already existent background. In this case, the performance of the single instrument and its additional value or conflict are analysed in the *Idea and Decision* phase and at the start of the *Implementation* Phase (Ring & Schlaack, 2011; Samset & Christensen, 2017). On the other hand, **Ex post** aims to analyse the existent

Policy Mix and evaluate the selected instruments and their interactions using criteria for single instruments analysis and designing of policy mixes. Moreover, Ex Post analysis will specially takes into consideration the outcomes of the policy, considering the final of *Implementation* and the *Operational* phases.

Considering the pathway for analysis and the context of the Policy Mix, the evaluator should define the information to collect and the criteria to use to evaluate these instruments individually. In this framework, the focus of analysis is not the individual instruments but their interactions since their mix and consequently interactions are what distinguishes the single Policy Analysis from the Policy Mix analysis. Therefore, this step should aim to collect information to support the analysis of their interactions. Two hypothetical situations are defined to clarify how pathways and context can change the information to collect and how to organise it:

- **Hypothesis 1:** the aim of analysis is to understand how different instruments interact between their different dimensions, goals and measures and contribute to a general Policy Mix. In this case, the single instruments analysis will collect and categorise the goals, measures, and other design features to follow the instruments interactions and final evaluation. Since we are at the start of implementation phase, it is not possible to collect the impacts of the Policy Mix and, consequently, only the official documents will be considered.
- **Hypothesis 2:** the aim of analysis is to understand how the existent Policy Mix contributed to achieve the goals established by the policies and how measures were the drivers for those impacts. In this case, different information assessing the indicators change and other reports will be organised and related to the measures. Finally, in the interaction analysis it will be identified where the instruments contributed positive or negatively to their impacts and the evaluation will focus on the effectiveness and efficiency of the Policy Mix.

This hypothesis are just two examples of how this framework for Policy Mix analysis can be applied. Different dimensions, elements, and characteristic can be selected for Policy Mix analysis. Consequently, the evaluation will also be influenced by the pathway selected.

Overall, different organisation methods and information can be used and collected. This step is essential to support the interaction analysis and consequent evaluation. The aim of this step is to give the evaluator the understanding of the instruments which, consequently, will help to identify the patterns, loopholes and design features of the Policy Mix. It is also important to note that different instruments can be selected for analysis and, therefore, this iterative process will require the capacity for adaptation of the data assessed.

3.4. INSTRUMENTS INTERACTION ANALYSIS

After the single instrument analysis, the information collected should be used to support the categories of instruments interactions. Interactions aims to visualize how the different instruments are related between them and identify the counterproductive or complementary aspects of their relations.

The proposed framework for Policy Mix analysis gives special attention to this step. The complexity of Policy Mix is to understand how instruments are affecting each other and, in and Ex Post scenario, the consequences of their implementation can be evaluated to further application of the Policy Mix.

A homogenous categorisation of the instruments interactions permits to directly compare their relations and identify the aspects which are more relevant or require special attention. Therefore, four different elements are proposed for categorization: (1) Types, (2) Dimensions, (3) Forms and (4) Combinations (table 24) (Flanagan et al., 2011; Gunningham et al., 1998; Milhorance et al., 2020; Ring & Schlaack, 2011; Schröter-Schlaack et al., 2013; Sorrell, 2003).

Table 24 Types, Dimensions, Forms and Combinations of Interaction

Types	Direct Interaction	Indirect Interaction	Operational interaction	Sequencing Interaction
Dimensions	Policy Space	Governance	Geography	Time
Forms	Different instruments, same actors or group	Different instruments, different actors or groups	Different instruments, different processes in broader 'systems'	Within the same instrument
Combination	Inherently complementary	Inherently Counterproductive	Path dependent	Context specific

First, four types of interaction are defined as:

- **Direct Interaction:** there is a clear influence between instruments and the change in one affects the other one.
- **Indirect Interaction:** there is an influence between instruments but a change in one does not necessarily affects the other.

- **Operational Interaction:** the instruments operate together but a change in one does not necessarily affects the other one.
- **Sequencing interaction:** the instrument is followed by another one in time.

However, another definition of different interaction types can also help to understand how to distinguish these types of interactions. Milhorance et al. (2020) identifies four types of interaction: (1) enabling, (2) facilitating, (3) consistency and (4) synergy. On figure 29, examples, description and types of deficits are presented with the associated type of interaction.

TYPE OF INTERACTION	ENABLING INSTRUMENTS		CORE INSTRUMENTS	
	Direct conditionality (enabling)	Indirect conditionality (facilitating)	Programmatic coherence (consistency)	Complementarity (synergy)
DESCRIPTION	Formal condition to implement another measure.	A measure “works better” if another measure is accomplished.	Results of a measure are consistent with the results of another measure, without direct interaction.	Implementation of a measure reinforces the outcomes of another measure (reciprocal).
EXAMPLES	<i>Coercive instruments that define the target public and enable other instruments.</i> <i>Examples: Target registries (e.g. CAR, DAP, social registry, and land titles) consist of formal requirements for the implementation of several credit, environmental, and social policies.</i>	<i>Non-coercive instruments that facilitate the implementation of other measures.</i> <i>Examples: These include mostly information instruments (e.g. technical assistance, climate projections, and indices) which strengthen policy goals of productive inclusion and climate policies.</i>	<i>Programmatic coherence without direct institutional or financial connection.</i> <i>Examples: Agribusiness credit lines (e.g. Moderfrota, Moderagro, Pronamp, and Moderinfra) have the same objectives and financeable items.</i>	<i>Complementarity in programmatic and/or procedural/financial aspects</i> <i>Examples: Ecoforte programme reinforces Planapo's production axis. Rural credit reinforces the outcomes of public food procurement from family farming (PAA, PNAE).</i>
TYPES OF DEFICT	Deficit in connection are often institutional/procedural. However, the design and mandate for issuing these instruments attract high political attention and conflicts of interest.	These instruments are rarely considered in the policy framework as preconditions to the implementation of the policy mix.	Programmatic incoherence is rare when analyses focus on policy design and institutional documents. However, policy conflicts in terms of rationales, goals, and implementation approaches are common in reality.	Deficits in connection are often institutional/procedural. National and territorial venues of coordination are key to promoting policy synergies and preventing conflict.

Figure 29 Types of Interaction. Source: (Milhorance et al., 2020)

Second, the dimensions and forms of interaction were based on different studies (Flanagan et al., 2011; Rogge & Reichardt, 2016; Sorrell, 2003). The **Dimensions** aims to assess how the Policy Mix presents interactions within the policy space, governance, different geographic spaces and in the time of development and/ or implementation. In the case of **Forms** of interaction, it is possible to distinguish if the mix occur in the instruments, actors our groups and/or within the instrument.

Lastly, **Combination** of instruments were divided in the four categories as presented in table 24 which were the result of adaptation to EP instruments combination of Ring and Schlaack (2011) and Gunningham et al. (1998) definitions:

- **Inherently complementary:** their interaction positively influences one another.
- **Inherently Counterproductive:** their interaction negatively influences one another.

- **Path dependent:** their interactions can be positively influenced by introducing a new instrument or reform existent instruments.
- **Context specific:** the instruments can positively influence each other depending on the context of their interaction.

3.4. EVALUATION: CRITERIA SELECTION

As result of the collected information and analysis, the final step is to evaluate the Policy Mix based on selected criteria. The criteria suggested was based on the collection of different authors (Mavrot et al., 2018; Mulligan et al., 2017; Rogge & Reichardt, 2016; Samset & Christensen, 2017) and should be selected based on the context and objectives of the Policy Mix analysed.

Consistency, Coherence, Credibility and Comprehensiveness are the four major criteria considered for analysis and are defined by the following questions by Mavrot et al. 2017:

- **Consistency:** are the elements of the policy mix aligned and work towards the same goal?
- **Coherence:** is the policy mix synergic and systematic?
- **Credibility:** is the policy mix believable and reliable?
- **Comprehensiveness:** is the policy mix extensive and exhaustive?

However, the context of the Policy Mix will limit the type of criteria used. For instance, credibility requires to understand how actors or other groups respond to the Policy Mix which, consequently, means the instruments selected need to support this conclusion. Furthermore, other types of criteria can also be used depending on the objectives, context, pathway selected and single instrument analysis. The evaluators should test and adapt these criteria to their needs (Mavrot et al., 2018; Samset & Christensen, 2017). The follow criteria have special contributions to the Ex-Post scenario and the evaluation of the Policy Process on the overall:

- **Stability:** how did the Policy Mix changed in the long-term and did it affect its stability?
- **Adequacy:** is there a concordance between the Ex Ante and Ex Post scenario?
- **Effectiveness:** were the goals achieved?
- **Efficiency:** how the resources were used to achieve the goals?

Finally, it is also possible to evaluate the type of Policy Mix (table 25) which is present in the analysis effectuated. In this case, it is proposed to evaluate the Policy Mix based on the previous work of Bouma et al. (2019) on Howlett and Rio (2017) which consider the number (single or multiple) of instruments, objectives, and government. Moreover, this typology could clarify if the instruments selected are actually a Policy Mix situation or Instrument mix which. Based on Howlett and Del Rio studies, the Policy Mix occurs when there is multiple government implicated.

Table 25 Typology of Policy Mix (S- Single and M- Multiple) adapted from Howlett and Del Rio (2015)

Policy Mix Category			Typology
Instruments	Objective	Government	
S	S	S	Simple Single-level Instrument Mix
S	M	S	Complex Single-level Instrument Mix
S	S	M	Simple Single-level Policy Mix
S	M	M	Complex Single-level Policy Mix
M	S	S	Simple Multilevel Instrument Mix
M	M	S	Complex Multilevel Instrument Mix
M	S	M	Simple Multilevel Policy Mix
M	M	M	Complex Multilevel Policy Mix

3.5. SYNTHESIS

The framework is essentially divided in five steps: (1) Definition of objectives, (2) Instrument Selection, (3) Single Instrument Analysis, (4) Instruments Interaction Analysis and (5) Evaluation.

First, the evaluator should define the objectives for the analysis. In this step, it is important to recur to the existent literature and start to understand the context to which the Policy Mix could be framed. The context will then influence the pathway to take for analysis. The **Ex Ante** scenario analyse the performance of the single instrument and its additional value or conflict and, on the other hand, **Ex Post** analyse the existent Policy Mix and will specially takes into consideration the outcomes of the policy. This is the starting point of the framework and, in case relevant information influence the pathway considered, the objectives can be redesigned, and the other steps will also be affected. In other words, the framework is an iterative process which is directly affected by the pathway chosen which is based on the Policy Mix context and affects the objectives defined.

Second, instruments need to be selected for analysis. In this step, the evaluator must comprehend how the objectives for analysis can be achieved by the instruments used and, therefore, the number and types of instruments should consider a previous criteria which consider the context of the Policy Mix. Then, these instruments are analysed on step three and four of the framework.

Fourth, Single instrument Analysis will define the information collected to support the analysis of their interactions and the overall evaluation of Policy Mix. Therefore, the evaluator should consider the chosen pathway since different type of information is needed to answer the different criteria selected. Again, this is an iterative process which can require the adaptation of the information collected and/or criteria used for evaluation.

Fifth, Instrument Interaction Analysis will categorize the interaction in four different elements: (1) Types, (2) Dimension, (3) Forms and (4) Combination. These steps aim to define an homogenous categorisation of the instruments interactions which permits to directly compare the instruments relations and identify the aspects which are more relevant or require special attention in the Policy Mix. The results of this step are also crucial for the overall evaluation of the Policy Mix analysed.

Finally, the evaluation should be performed based on the selected criteria. In total, eight different criteria - Consistency, Coherence, Credibility, Comprehensiveness, Adequacy, Stability, Effectiveness and Efficiency – can be used in different scenarios which are related to the context and pathway of the specific Policy Mix. The figure 30 illustrates the iterative process and the Framework for Policy Mix Analysis, presenting its five steps previously explained and the secondary steps (Contextualization and Pathway).

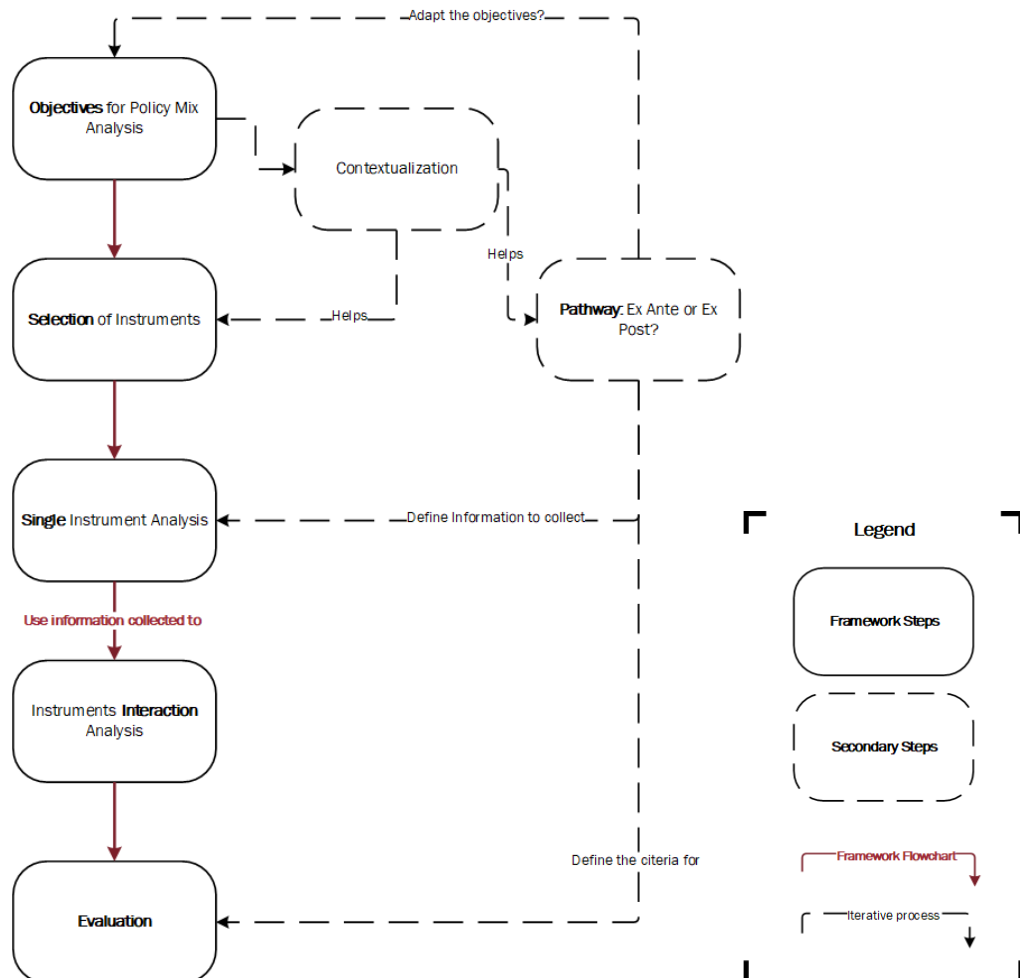


Figure 30 Framework for Policy Mix Analysis

4

PORTUGUESE POLICY MIX ANALYSIS ON ENERGY POVERTY

4.1. INTRODUCTION

Energy Poverty is currently being discussed in various policy dimensions around the world (table 26). OECD, European Union and Portugal all have increasingly discuss how policies are an important part of tackling the EP issues and how its complex nature encompass the mix of different instruments, actors and other attributes of policy mix (de Matos, 2017; European Commission, 2020b; Horta, 2020; OECD, 2007; Rodrigues & Moreira, 2018).

Table 26 Case Study Guidelines on Energy Poverty

	Theme	Goal	Based on
EPI	Energy Poverty Policies	Q1 What are the important characteristics of EP?	(Schröter-Schlaack et al., 2013)
		Q2 What are the policy objectives?	
		Q3 What are the Drivers of EP?	
EPr	Energy Poverty Problematic	Q1 Who is suffering from fuel poverty in the region, and what are the underlying reasons?	(Gouveia et al., 2018)
		Q2 How thermal comfort is overcome with energy efficiency measures in buildings?	
		Q3 How fuel poverty relates with health issues, namely premature deaths during heat waves and cold periods?	

In this chapter, Portuguese Energy Poverty policies will be the case study to test the proposed Policy Mix Analysis Framework. First, the contextualization of the EP problematic in Portugal will contribute to identification of the socio-economic and physical drivers of EP and the literature analysis which will consequently justify the selection of the Portuguese Case Study and its integration in the European Union context. Furthermore, the application of the Policy Mix Analysis Framework will be presented, discussing the thematic contextualization and the consequence pathway selected and the information to collect. This framework will be based on the Ex Ante pathway.

In summary, the major goal of the policy mix analysis framework on the Portuguese case study of EP problematic is to combine the three different latest discussed topics (Policy Mix, Coherence and Energy Poverty) in an analysis of instrument interaction and utilization of Coherence and Consistency as the core criteria. With this framework, it will be possible to discuss how a EP involves different dimensions, the mix of policies and how the monitoring of the success of their implementation is related to Policy Mix and Policy Coherence debate.

4.2. ENERGY POVERTY IN PORTUGAL

4.2.1. PORTUGAL IN EUROPEAN UNION

In a comparative study of 5 EU countries EP policies and measures, Portugal (PT) is compared with Cyprus (CY), Spain (ES), Bulgaria (BG) and Lithuania (LT) in an overview of selected policies directly or indirectly targeting energy poverty (Kyprianou et al., 2019). Until 2019, before the development of the *Estratégia Nacional de Longo Prazo para o Combate à Pobreza Energética 2021-2050 (ELPCPE)* (República Portuguesa, 2021b), national legislation of Portugal only measures on energy prices were employed to protect vulnerable energy consumers through a social tariff rate and through the previously enunciated programmes on improvements of household by energy efficiency measures. Table 27 illustrates the comparison of Portugal with other four countries on efforts to mitigate EP through measures, definition and EP and vulnerable consumers compared. The definition of vulnerable consumers until 2019 generated a “high degree of differentiation between them and general population” which do not consider the “just at-risk consumers”. Authors suggest that a more diverse action and deemphasizing of energy efficiency would benefit Portugal alleviation of Energy Poverty.

Table 27 Comparison of 5 EU countries on efforts to mitigate Energy Poverty. Source:(Kyprianou et al., 2019)

MS	EP definition	Energy vulnerable consumer	Consumer protection measures	Financial aids	Energy Savings	Information provision	Relative score
CY	X	X	X		XX		5
ES		XX	XX	X	XXX	X	9
PT		XX	X		XXXX		7
BG		X		X	X		3
LT		X	X	X	XX		5

The Annex 3 present 8 tables exposing the comparative analysis of the five countries in a more completed approach. In those tables it is possible to notice that, until 2019, in Portugal: (1) there was not a national definition of EP; (2) vulnerable consumers definition was based in a social welfare system and related energy consumption with contract limitations; (3) social tariff and extraordinary social support were the two type of measures identified by the authors; (4) there was no financial aids; (5) six energy savings measures were identified by the authors and (6) there were not information provision measures.

4.2.2. INDICATORS AND POLICIES TIMELINE

In six recent publications on the EP-Pedia on the ENGAGER website, Gouveia and Palma present synthetic articles exposing different contextualization topics on EP in Portugal (Gouveia & Palma, 2021f, 2021e, 2021d, 2021c, 2021b, 2021a). On table 28, the authors summarise and compare with the EU 27 Member States four different income-related indicators. Inequalities are pointed by the Gini Index and the income distribution ration which are higher than the average of EU, being the eight highest income distribution ratio in the EU. It is added that Portugal is, respectively, the first and fourth highest prices of natural gas and electricity for household consumer prices in the EU-27.

Table 28 Income-related Indicators for Portugal and the 27 European Union Member States.
Source:(Gouveia & Palma, 2021a)

	Portugal	EU-27
Adjusted disposable Income per capita (€)	19 569	23 388
Gini index (%)	31.9	30.2
Income distribution ratio	5.2	5.0
Risk of Poverty (%)	17.2	16.5

12

In addition to the already presented information about Portuguese climate, temperatures and precipitation, Gouveia and Palma (2019) discuss how households deal with excess heat and cold respectively in summer and winter seasons. Although Portugal is among the warmest countries in Europe, the fact it is located in the Iberian Peninsula make the future of the country a reality to face climate change impacts which are projected to increase the cooling degree-days and decrease the heating ones in 2050.

Energy efficiency takes an important step to deal with the high consumption of the households when dealing with excess temperature. With 3.5 million classic residential buildings and 5.9 million

¹² Gini Index measures the inequality of income distribution (PORDATA, 2021)

dwellings, Portugal deals with old residential building, commonly structured with stone or brick masonry and with approximately 70% of them built prior to the implementation of energy performance regulations. Figure 31 illustrates the evolution of Energy Performance of Buildings (EPB) regulations in Portugal. The first regulation implemented in 1990 was replaced in 2006 with the Thermal Performance Buildings Characteristics Regulation (RCCTE). This was a consequence of the more demanding settings of European Directive 2002/91/CE on Energy Certification System (SCE). Later, in 2013, after the new EU directive on building energy performance in 2010, Residential Buildings Energy Performance Regulation (REH) and Commercial and Service Buildings Energy Performance Regulation (RECS) are implemented. Lastly, in 2018, an EU directive is presented as an amending of the Directive 2010/31/EU on the energy performance buildings (Gouveia & Palma, 2021d).

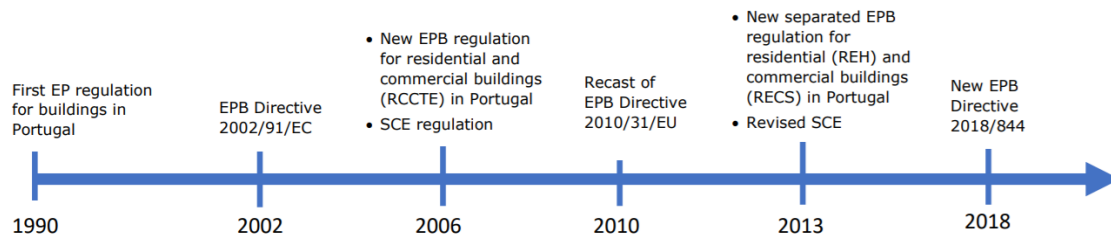


Figure 31 Timeline of Energy Performance regulations in Portugal. Source: (Gouveia & Palma, 2021d) ¹³

In the same article, Goveia and Palma note that there is a need on energy efficiency improvement for buildings since in the last 10 years there has been a low annual rate of 0.012% on deep renovation or reconstruction of buildings. In a study of energy efficiency and comfort evaluation, results show that 34% of the total spending of the Portuguese construction sector in 2014 was in refurbishment costs and noted that the older buildings with historical and architectural value is a constraint to thermal improvement measures because of the regulations implemented which define their preservation and, in some regions, the obligatory of following traditional regional construction procedures and materials. This situation comes in hand with the lowest energy consumption rates of Portugal in EU, which will be further explained.

Different programs and other measures on energy efficiency of the housing stock take place in Portugal. Four major policies are identified to tackle Energy Poverty through Energy Efficiency: **Plano Nacional de Energia e Clima (PNEC)**, **Roteiro para a Neutralidade Carbónica 2050 (RNC 2050)**, **Plano Nacional de Ação para a Eficiência Energética (PNAEE)** and **Estratégia de Longo Prazo para a Renovação de Edifícios (ELPRE)** (PNAEE - Plano Nacional de Ação Para a Eficiência Energética, 2013; República Portuguesa, 2019b, 2019c, 2021a). These policies have in common the

¹³ Note that EP in this case means Energy Performance and not Energy Poverty

focus on building intervention and energy efficiency focus to deal with EP. Under the PNAEE, *Aviso 25* (República Portuguesa, 2018b) is a program which this year was discontinued and which financed, yearly, “up to 60% of energy efficiency measures for residential and service buildings, including the insulation of efficient solar water heating systems” through the 1.55M € of the Energy Efficiency Fund in a non-repayable grant scheme. The priority was the older buildings with best opportunity for energy efficiency improvement and primary energy savings which do not target only energy-poor households (Gouveia & Palma, 2021d).

Casa Eficiente (República Portuguesa, 2020a) and ***Instrumento Financeiro Reabilitação e Revitalização Urbana (IFRRU)*** (República Portuguesa, 2020b) are soft-loan based schemes for building renovation. The first, aim to improve environmental performance through “application of thermal insulation in walls, replacement of frames, optimization of elevators, installation of solar photovoltaic panels, installation of solar thermal systems, acquisition of appliances of high energy and water efficiency”. On contrary to the *Casa Eficiente* which targets all residential buildings, IFRRU has a range of 30 years old or older buildings in a precarious conservation state and supports “building envelope renovations, HVAC systems replacement and renewable energy systems installation”. Another national schemes for improvements of vulnerable households are *1º Direito* (República Portuguesa, 2018a) and *Reabilitar para Arrendar* (República Portuguesa, 2015) which both target precarious buildings particularly in vulnerable neighbourhoods and aim to improve buildings through grants and loans. At last, in late 2020, 4.5M€ were provided through non-refundable subsidies to energy efficiency projects through the *Programa de Apoio a Edifícios Mais Sustentáveis* (República Portuguesa, 2020d) financed by the Fundo Ambiental under the ***Programa de Estabilização Económica e Social (PEES)*** (Gouveia & Palma, 2021d; República Portuguesa, 2020c).

4.2.3. ENERGY POVERTY VULNERABILITY INDEX AND INTERVIEWS

In another a study published in 2019, an energy poverty vulnerability index (EPVI) is presented as a spatial scale composite index which permits mapping and highlighting hotspots of energy poor regions. First, authors start by presenting the justification of considering Portugal to test the EPVI. The authors reasons are identified on the left column of table 29 and the other columns are the existent updated information and their respective sources.

Table 29 Energy Poverty contextualisation in Portugal in numbers. Source: based on presented indicators of (Gouveia et al., 2019) and updated.

Reasons (Gouveia et al., 2019)	Updated	Source (most recent)
5 th highest out of all 28 EMS rate of people unable to maintain adequate warmth in their dwelling during the winter (22.5%, in 2016)	Inability to keep home adequately warm- 18.9% (4 th highest out of all 28 EMS in 2019)	(EUROSTAT, 2021b)
2 nd highest out of all 28 EMS percentage of people living in a dwelling which was not comfortably cool during the summer (35,7%, 2012 data)	-	(EUROSTAT, 2021f)
Ageing building stock with low energy performance (74% of houses with energy performance certificate (EPC) below or equal to a C class	61% of houses with energy performance certificate (EPC) below or equal to a C class in 2019	(Observatório da Energia, 2020)
Decentralized low efficiency climatization systems and low ownership rates, mainly for cooling equipment — 15,7%	-	(INE, 2017)
Among the highest energy prices in the EU (both electricity and natural gas)	8 th highest electricity prices (including taxes) for household consumers, second half 2020 5 th highest natural gas prices (including taxes) for household consumers, second half 2020	(EUROSTAT, 2021a, 2021e)
low household income	17 th lowest out of 28 EMS, Mean and median income by household type in Euro Area (2019)	(EUROSTAT, 2021d)
One of the highest mortality rates in winter, despite the Mediterranean climate	-	(Liddell et al., 2016)
a dual problem regarding thermal comfort: both for space heating and cooling energy demand	-	(Gouveia et al., 2019)

Second, EPVI is presented and explained how it considers different drivers and indicators of energy poverty represented by two sub-indexes: dwellings' energy performance gap (EPG) and Population's ability to implement alleviation measures (AIAM). The former takes in consideration the energy

consumption for space heating and cooling and the final energy consumption estimation of the dwelling and per civil parishes, which makes it an indicator of the building stock's energy efficiency. The latter is considered a socioeconomic index, representing the knowledge and financial resources of the population based on 7 standardized indicators and rationales: (1) share of population with age equal or lower than 4 years old; (2) share of population aged 65 and over; (3) average monthly income per capita; (4) share of dwellings' owned by the occupant; (5) share of the population with a university degree; (6) unemployment rate; and (7) building state of conservation. The EPVI varies between 1 and 20, the higher value representing the maximum gap and the ability to implement measures which make possible to identify the regions where populations risk of EP is higher and the probability of finding energy-poor consumer is greater (Gouveia et al., 2019).

The results of EPVI are presented to each civil parishes in figure 32 and EPVI is higher in cooling than heating needs. However, authors explain that energy consumption and health effects in winter-related EP makes it more significant type of EP combat in Portugal. The heating needs of civil parishes are higher across rural inland region of mainland Portugal, related to the AIAM sub-index levels, and the higher cooling EPVIs are located in inland north and central region, not only related to AIAM sub-index levels but also the low ownership rates of cooling equipment. It is possible to highlight two problems identified by this study: energy poverty and poor indoor thermal comfort in Portugal.

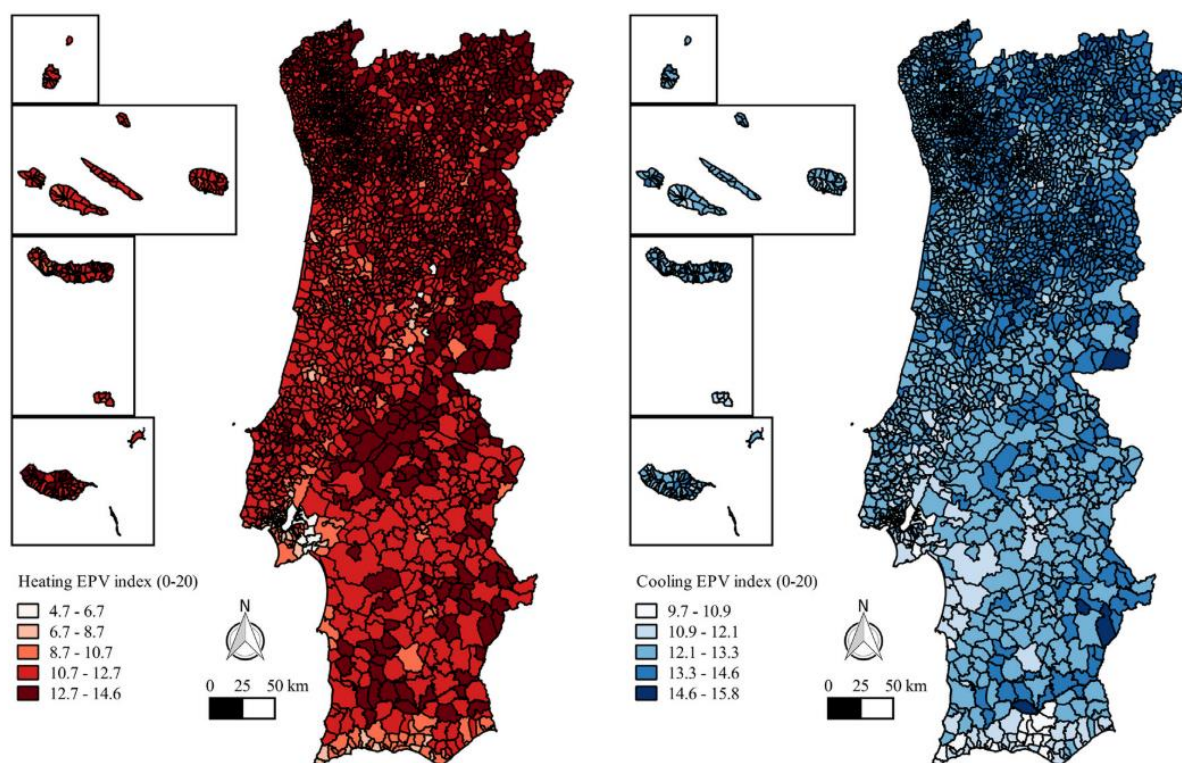


Figure 32 Energy Poverty Vulnerability Index (EPV index) for heating and cooling in Portugal. Source: (Gouveia et al., 2019)

Furthermore, another study interviews 100 households and 134 interviewees in ten hotspots across Portugal which is combined with the EPVI and mapping in the previously mentioned study. Through the interviews, authors explore “*perceptions, understandings and practices of coping with energy poverty*”. The key questions of the interviews include 4 topics: “(1) *characteristics of the dwelling (year of building completion, number of rooms, sun exposure, type of tenure, presence of leak, damp or rot, among others)*; (2) *history of works carried out in the dwelling/building*; (3) *available equipment (including heating and cooling systems)*; (4) *satisfaction regarding the dwelling, thermal comfort at home, and doings to cope with cold and heat at home, among other topics.*”. On figure 33, information of the ten selected civil parishes, highlighting shows that energy poverty vulnerability is prevalent across the country since the average EPVI for space heating and cooling is respectively 12 and 13.2 (Horta et al., 2019).

NUT2	NUT3	Municipality	Civil Parish	Population	Typology	EPVI Heating	EPVI Cooling	Social energy tariff (%)	Social Housing (%)	Non-classical dwellings (%)
Alentejo	Baixo Alentejo	Ferreira do Alentejo	União das Freguesias de Ferreira do Alentejo e Canhestros	5140	Rural	12.1	13.1	16.9	0.0	1.2
Área Metropolitana de Lisboa	Área Metropolitana de Lisboa	Cascais	Alcabideche	42162	Urban	11.8	12.3	17.3	3.3	0.4
Área Metropolitana de Lisboa	Área Metropolitana de Lisboa	Lisboa	Ajuda	15617	Urban	10.7	12.2	14.5	9.4	0.1
Centro	Beiras e Serra da Estrela	Seia	Loriga	1053	Rural	11.9	13.9	24.4	0.1	0.0
Norte	Ave	Guimarães	Barco	1510	Rural	14.1	14.6	22.8	2.8	0.0
Norte	Ave	Guimarães	Fermentões	5707	Urban	11.7	13.2	22.8	2.8	0.0
Norte	Terras de Trás-os-Montes Área	Bragança	Salsas	389	Rural	14.0	14.5	24.2	1.9	0.0
Norte	Metropolitana do Porto	Porto	Campanhã	32659	Urban	11.8	12.8	18.0	13.8	0.6
Centro	Região de Coimbra	Figueira da Foz	São Pedro	2910	Urban	11.1	13.6	2.3	2.2	0.2
Algarve	Algarve	Olhão	Quelfes	17246	Urban	11.0	12.5	22.2	4.4	0.3

Figure 33 Information on the ten selected civil parishes. Source: (Horta et al., 2019)

Through the developed interviews results show that thermal discomfort is acknowledged by 84% of the interviews and 56% recognise problem with indoor thermal discomfort both in winter and summer. The perceptions of temperature are presented in table 30.

Table 30 Household's perceptions of temperatures at home in winter and summer (n=100). Source: (Horta et al., 2019)

		In Winter		
		Very cold	Cold	Mild
In Summer	Very hot	19	11	4
	Hot	7	19	4
	Mild	9	11	16

Thermal comfort is influenced by cultural and social factors which may present a justification on how low incomes households tend to underestimate thermal discomfort and their coping methods of using “enough clothes” or becoming “used to it”. These households are not able to afford technical solutions to their problems making the acceptance and resignation a consequence of their reality. The normalization of thermal discomfort is affected by how most part of interviewees households all had the same similar conditions which contrast with people which experienced living in a warm home earlier mention the discomfort more easily.

Authors also refer that different generations influence the expectation regarding thermal comfort and that the main reason pointed for being unable to keep homes warm is the high cost of energy, especially electricity. Warm environments indoor are understood as a waste of money or luxury and coping methods with cold temperatures are mentioned such as going to bed earlier, ‘working’ mostly in housework or moving around, only using devices for less than an hour per day or through ways which do not require energy consumption. When it comes to dealing with heat, common practices are mentioned such as showering with cold water more than once a day, wearing less clothes, removing all blankets from beds or going outdoors. Insulation is mentioned as an recognised factor by the above average of both income and education levels households.

Based on these two presented studies, it is possible to comprehend how Portugal is currently dealing with an EP issue all over the territory and the building stock and socioeconomic factors are important indicators to consider when assessing the problem. The younger generations are presented with different demanding expectations when it comes to thermal comfort and building insulation. Energy prices have an important consideration defining cultural coping methods with thermal discomfort and it is related to energy efficiency of the dwellings. On the latter study, authors defend that “*results suggest that measures for alleviating energy poverty should, first and foremost, focus on financing improvements in dwellings and specifically target households with low income*”. However, it is important to note that lower income households are not synonym of energy-poor problems, but an accentuation of the difficulties faced by those who face EP.

In addition to the interviews developed by the previous study, two different surveys were considered, (EUROSTAT, 2021c, 2021g; Portal da Construção Sustentável & QUERCUS, 2017).

The first, Survey on Income and Living Conditions (SILC), an annual survey conducted by EU, found that Portugal has the fourth highest rate of inability to maintain dwellings adequately warm during winter and the second highest one of population living in dwellings with leaking roof, damp walls, floors or foundation, or rot in window frames or floor in the EU.

The second, *Portal da Construção Sustentável* (PCS) and QUERCUS survey in Portugal, was an eight question-online survey on thermal comfort which identified the difficulty in maintaining an adequate temperature in households, 74% of the interviewees considered their housing cold in winter and that 89% and 63% respectively consider the need to increase their energy consumption in order to maintain adequate room temperature during the winter or summer (Gouveia & Palma, 2021c). These surveys come as another support to the conclusion of how EP problematic in Portugal is related to high prices on energy household consumption and both heating and cooling issues are present in the households of the country. The north region and centre inland deal with cold homes in winter and the inland north and centre regions with excess heat in summer.

4.3. APPLICATION OF THE FRAMEWORK FOR POLICY MIX ANALYSIS

The flowchart of the framework is presented on figure 34 to better understand the essential steps and different categories used to analyse and evaluate the Portuguese Energy Poverty Policy Mix Case Study.

As was previously mentioned in the proposal of the Framework for Policy Mix analysis, the context of the instruments establish a major factor to apply the segments of the framework. Therefore, it will be clarified how the instruments were selected, the information collected and the criteria which will be used. The pathway considered was **Ex Ante** since the instruments selected are, in general, at the start of implementation and, therefore, there is not enough information to cover the Ex Post case.

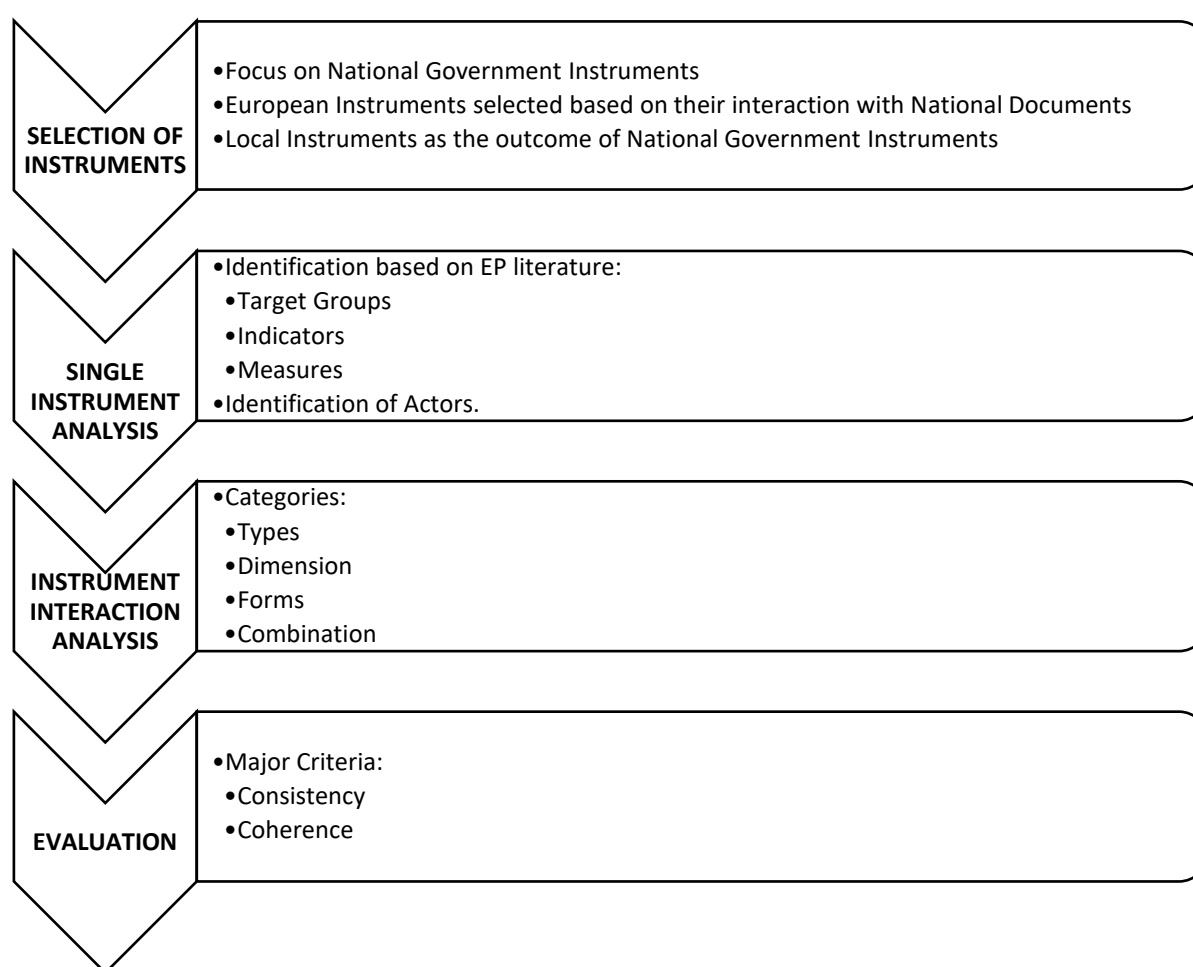


Figure 34 Framework for Policy Mix Analysis

4.3.1. INSTRUMENTS SELECTED

In the beginning of 2021, Portugal takes the Presidency of the Council of the EU in a time which COVID-19 pandemic and socio-economic consequences were considered the challenge to face in the 6 month period of presidency (Portuguese Presidency of the Council of the European Union, 2021a). The action lines of Portuguese presidency are: Resilient, Green, Digital, Social and Global Europe. In its programme it is mentioned how “*promotion of energy efficiency, with a special focus on tackling energy poverty, in particular in the context of the ‘renovation wave initiative’ intended to improve the energy performance of buildings and positively impact economic and social recovery*” (Portuguese Presidency of the Council of the European Union, 2021b).

At the same time, different news focus on climate, for instance, the development of the Climate Law by the EU (Lusa, 2021) and two different strategies by the Portuguese government are discussed on the media: *Estratégia de Longo Prazo para a Renovação de Edifícios* (Ribeiro, 2021) and *Estratégia de Longo Prazo para o Combate da Pobreza Energética* (Idealista news, 2021).

On the other hand, the European Union instruments are an important factor to generate other levels policies. For instance, after the analysis of evolution of European Union policies for Energy Poverty the EPOV and ENGAGER are both important data source about the topic whose creation is directly related to EU efforts to combat EP. These initiatives were both extensively used to understand what was being applied in EU and Portuguese Context and, as will be further explained, also were crucial to define the criteria to analyse the instruments.

This observation of the emergence of new policies and the discussion by different level of government was important to define the Portuguese context of Energy Poverty. Thereupon the emergent politic debate and the policies being approved in the beginning of 2021, it was defined that the case study would focus on the Portuguese National Government documents approved in the late 2020 and early 2021. The other level documents would be selected considering its relation to the national ones and their recentness. In total, 10 instruments were selected for analysis.

The Local instruments were considered as the application of National and integration of EU instruments to analyse the concretization in a more direct context. Although *Just a Change* (Just a Change, 2021) is not a direct application of the National Government instruments analysed, it was identified in 2021 as one of the best current practices in Portugal “*for combatting energy poverty from the policy side pertain to the implementation of identified measures to support vulnerable households*” (Gouveia & Palma, 2021b).

In table 31, in addition to the name and code of the 10 instruments selected for analysis, it is possible to observe that only 2 instruments, JAC and *Habitação A+*, were not implemented in the last 3 years and that 2 instruments, ECL and ELPCPE, should start being implemented in 2021 but are currently being discussed. The period of implementation ends generally at 2050, being the PNEC and PRR the only ones ending earlier, and the local instruments do not have a end date previewed.

Table 31 Instruments selected for Analysis

	Instrument		Status	Implementation		Source
	Code	Official Name		Start	End	
European	CEP	Clean Energy Package for All Europeans	Legislative Directive (EU) 2018/844 Directive (EU) 2018/2001 Directive (EU) 2018/2002 Regulation (EU) 2018/1999 Regulation (EU) 2019/943 Directive (EU) 2019/944 Regulation (EU) 2019/941 Regulation (EU) 2019/942	On going	2019	(European Union, 2019a)
	RW	Renovation Wave	COM(2020)662	2020		(European Commission, 2020c)
	ECL	European Climate Law	COM(2020) 80	Provisional agreement	2020	(European Commission, 2020a)
	ELPCPE	<i>Estratégia Nacional de Longo Prazo para o Combate da Pobreza Energética</i>	-	Public Consultation	2021	(República Portuguesa, 2021b)
	ELPRE	<i>Estratégia Nacional de Longo Prazo para a Renovação dos Edifícios</i>	Resolução n.º 8-A/2021		2021	(República Portuguesa, 2021a)
National	PNEC	<i>Plano Nacional Energia e Clima 2021-2030</i>			2021	(República Portuguesa, 2019b)
	PRR	<i>Plano de Recuperação e Resiliência</i>		On going	2020	(República Portuguesa, 2021d)
	JAC	Just a Change	-		2010	(Just a Change, 2021)
Local	GAE	<i>Gabinete de Aconselhamento de Energia</i>			2020	(DECO, 2021)
	Habitação A+	<i>Projeto Habitação A+</i>			2017	(AdE Porto, 2021)

4.3.2. APPLICATION OF THE FRAMEWORK PROPOSED ON THE CASE STUDY

4.3.2.1. Instrument Analysis

Policy Mix depends “*on the dynamic institutional context in which the policies are embedded*” (Magro & Wilson, 2019) and Energy Poverty “*exhibits great context specificity*” (Sareen et al., 2020). As identified by Sareen et al., a dilemma appears related to the “*inexistence of universally optimal balance between context provision and removal*” since “*if data come with too little context, accountability relations are weakened or destroyed, but providing too much context may be overwhelming and paralyse action*”. For this reason, understanding the Energy Poverty metrics and its contextualization in the case study was a vital step to define the criteria to analyse instruments and their interaction.

Instruments will be firstly subjected to the identification of **target groups**, **measures**, and **indicators**. This selection was based on the literature on EP and the policy guidance provided by EPOV (EPOV, 2021a).

While drafting policies to address energy poverty, EPOV recommends the focus on four different topics: (1) Measurement, (2) Definition, (3) Policy type and (4) Financing & Funding (table 32).

First, Measurement will be considered in this framework as the contextualization of EP problematic in Portugal which was previously discussed. Second, definition of energy poor and vulnerable household will be taken notice when analysing the target groups of the instrument or general goals. Third, policy type will be accessed when considering the measures that instruments give to tackle EP. Lastly, the fourth suggestion on the Finance & Funding will be considered not only by the analyses of the different measures applied in the instruments but also the identification of the **actors** which are directly or indirectly related to them.

Table 32 Policy Guidance on Energy Poverty. Source: adapted from (EPOV, 2021a)

MEASUREMENT	Energy costs and income: quantify energy poverty by looking at the energy expenditure of households in relation to an income measure. Self-assessment: assess energy poverty by asking households directly to what extent they feel able to afford energy. Direct measurement: measure physical variables to determine adequacy of energy services. Proxy indicators: give an impression of the energy poverty situation through related factors, such as arrears on utility bills, number of disconnections and housing quality.
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DEFINITION	Socio-economic group: some socio-economic groups are known to be particularly vulnerable to energy poverty. Housing situation: certain housing situations are known to present certain risks in terms of energy poverty. Energy carrier: use of certain energy carriers is known to be related to energy poverty. For example, in certain countries the use of expensive and inefficient heating oil boilers would make households more vulnerable to be energy poor. The Policies & Measures section allows to select example policies that target specific energy carriers. Location: certain areas are known to have more households in energy poverty.
POLICY TYPE	Financing improvements in the energy situation of households is the most preferred option to solve energy poverty structurally. Energy audits are visits to vulnerable households to provide direct advice on how to improve their specific situation. Financial assistance to reduce energy bills can be given in two ways. Social tariffs and energy bill support. Disconnection protection provides protection against disconnection for households, often in colder months during wintertime. Information and awareness are measures that indirectly facilitate households to improve their situation by providing advice, information, or education. Social support provides general income support for households to cover more general expenses.
FINANCING & FUNDING	Financing specific improvements, through Tax incentives, Grants and Loans. The funding of measures can be done through Public funding, Private funding, Public-private partnerships or levies.

The aim of the **Single Instrument** analysis application on the Portuguese Case Study is to consider the existent information on how Energy Poverty policies are and/or should contemplate the problematic. Then, the essential information collected will be considered for posterior analysis and support of the **Instruments Interactions**. Therefore, homogeneity of the categories is an important factor to better compare the instruments.

Milhorance et al. (2020) present a “*framework for analysing interactions between policy instruments and actors based on documentary data*” which combines Policy Mix and policy network analysis. Based on the information collected by the authors, presented on figure 35, the selected instruments of

the case study are subjected to data extraction of essential information to better comprehend and compare the instruments and organized in different tables.

Characterisation	→ Programme name → Government reference plan → Level (national, regional, state, or local) → Policy field (agriculture/livestock, agro-extractivism, forestry, environment, land tenure, or social protection/assistance) → Goals
Programmatic features	→ Type of instrument (direct intervention, coordination, regulatory, or information system) → Characterisation of the instrument (rural credit, rural insurance, environmental inspection, environmental/land regularisation, etc.) → Target public
Governance	→ Coordination venues → Actors – responsible organisation → Actors – formal co-implementation partners → Actors – funding organisations
Implementation	→ Targeted municipalities → Starting year → Period
Funding	→ Volume of funds invested in Mato Grosso (2013 – 2017) → Volume of funds invested in actions without a territorial definition (2013 – 2017)
Additional information	→ Documental source → Legal instrument

Figure 35 Information collected for the framework analysis. Source: (Milhorange et al., 2020)

In summary, the selected instruments will be analysed considering the measures, targets, indicators and actors to further understand the nature of each instrument and, then, apply the information collected to the Instruments Interactions Analysis. The Instruments Interactions Analysis will be followed as proposed on the framework.

4.3.2.2. Criteria selected for the Evaluation

The focus of the evaluation will be to use **Coherence** and **Consistency** as the major criteria. On the one Hand, Consistency will evaluate the instruments based on the 4 elements collected from the single instrument analysis, On the other, instruments interactions will be evaluated under the Coherence criteria. These two criteria are illustrated as two axis (figure 36). Consistency is the vertical axis which evaluates the target groups, measures and indicators and Coherence is the horizontal axis assessing how interactions occurs between instruments. Credibility and Comprehensiveness will be considered while discussing the results.

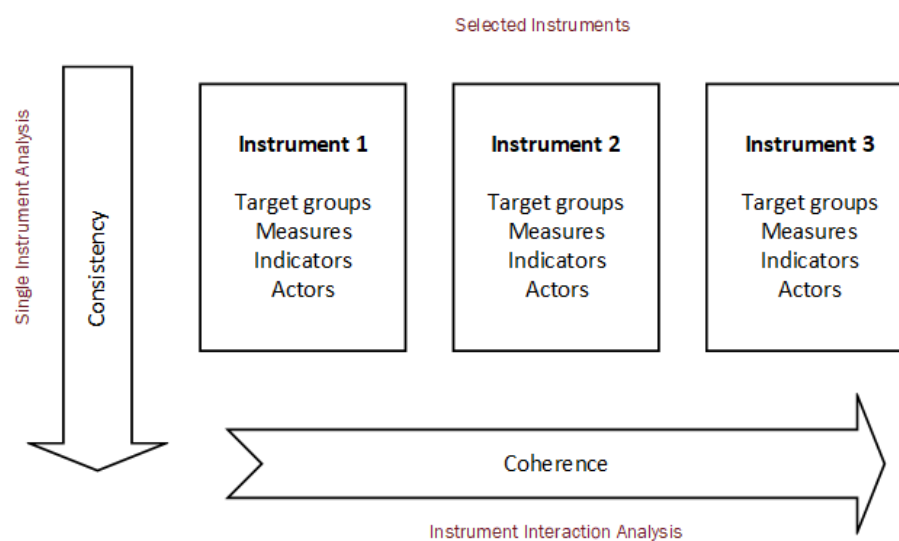


Figure 36 Policy Mix Evaluation Criteria framework

Stability and adequacy were not considered since the recentness of the selected instruments would not provide adequate information to evaluate the “concordance between the initially planned delivery and the effectively implemented delivery”- **Adequacy**- and the long-term stability of the policy mix. For the same reason, **Effectiveness** and **Efficiency** will not be applied, too.

Comprehensiveness will be discussed during the single instrument analysis. **Credibility**, on the other hand, will not be used since there are instruments that have not yet be implemented. These criteria should specially consider the views of the actors and/or entities related to the Policy Mix which should be analysed through interviews or other documents contemplating the general answers to the instruments application. Because of the recentness of the topics and the selected instruments, these criteria could not be fully covered.

In retrospect, the evaluation of the Policy Mix will be based in two major criteria: Consistency and Coherence. Consistency evaluates how the collected data from the single instrument analysis are aligned with the same goal(s). Coherence focuses on the interaction of the instruments and their context. In this case, two types of coherence will be discussed: intra and inter settings coherence. The intra-setting incoherence could happen when policy mix within a particular context lacks coherence and inter setting when the coordination of the individual instruments do not contribute to their synergy and redundancy or counterproductivity can occur. In addition to these criteria, comprehensiveness will be considered during the single instrument analysis to discuss the difficulties found to address the information which was collected.

4.4. RESULTS

4.4.1. SINGLE INSTRUMENTS ANALYSIS

The Single Instruments Analysis aimed to overview each individual instrument in their different fields and goals to further understand the interactions between them analysed in the next step of the framework. Since Energy Poverty is them of the Policy Mix addressed, the information collected should represent the thematic to observe how the instruments contribute, or not, to its mitigation.

In total, 10 instruments were analysed individually, collecting their goals, target groups, measures and indicators. One of the instruments, CEP, consists in a package of 8 instruments itself. Since it was needed to develop an extensive and exhaustive analysis of the instruments, the results for the Single Instruments analysis will start by highlighting the information which was essential to understand the Portuguese Policy Mix on Energy Poverty and, then, each instrument will be further explained in addition to their individual results.

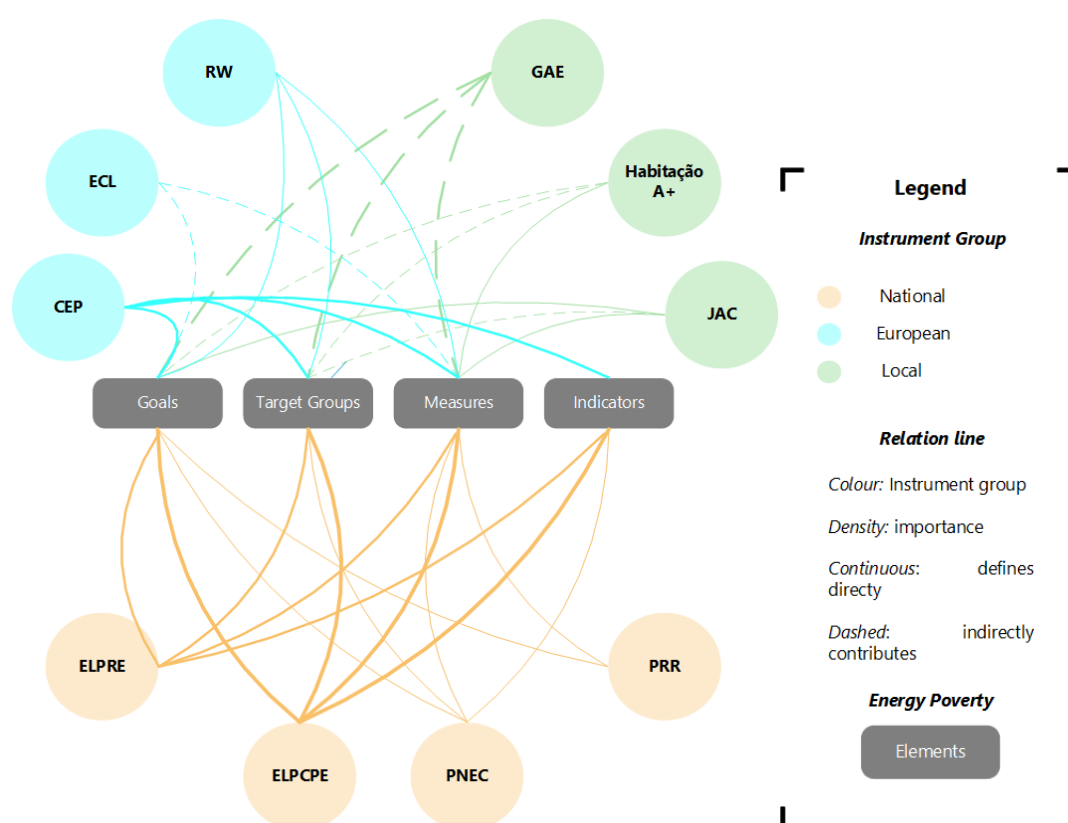
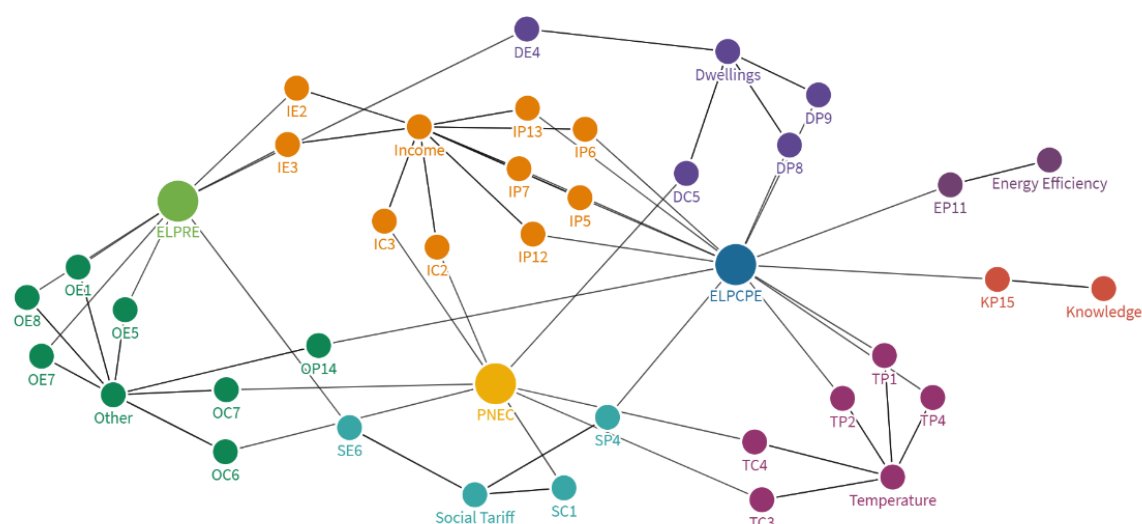


Figure 37 Synthesis of the Instruments contributions for 4 elements of Energy Poverty

As can be observed in figure 37, the three different levels of the instruments contribute differently to the Energy Poverty fight. The local instruments, in green, all indirectly contribute to the elements of the Energy Poverty, in grey. The density of the lines represents how the instruments individually contribute to the Energy Poverty Combat. CEP, ELPCPE, ELPRE and GAE are the ones which develop the Energy Poverty issue and directly aim to fight it through different measures. To understand how these instruments individually contribute to the EP issue, the following segments will further explain how their single analysis could assure their relations to the Energy Poverty elements.

The indicators will also be organized in different groups and with codes representing the first letter of the indicator group, the assigned letter of the instrument (ELPRE-E, PNEC-C and ELPCPE-P) and a different number to each indicator. The reason to the indicators only being associated to ELPRE, PNEC and ELPCPE is that these were the instruments which directly identify the indicators used to assess Energy Poverty (figure 38).



Legend

Instrument

● ELPCPE ● PNEC ● ELPRE

Indicator Group

● Temperature ● Social Tariff ● Income ● Dwellings ● Other ● Energy Efficiency ● Knowledge

Indicator Code

Indicator Group | Instrument Letter | #

Figure 38 PNEC, ELPRE, ELPCPE and their interactions with the different groups of energy poverty indicators

In addition to what will be observed in the individual results of the instruments, the figure 38 allows us to observe that the most used groups of indicators are the ‘other’ and ‘income’. Then, the ‘social tariff’ and ‘temperature’ groups are the major groups considered. The aim of the dissertation is not to understand how these groups are effectively, or not, contributing to the Energy Poverty fight but identify how the instruments are following common lines in its design and interactions.

4.4.1.1. Estratégia Nacional de Longo Prazo para o Combate da Pobreza Energética

Estratégia Nacional de Longo Prazo para o Combate à Pobreza Energética (ELPCPE) is the first step to define a strategic framework to fight energy poverty by the Portuguese Government. This instrument is integrated in a broader framework to tackle climate change, economy recover, mitigation of social inequalities and life conditions improvements (Annex 4).

Firstly, while defining the European and National Framework of the strategy, various instruments’ goals are presented and their contributions to the energy poverty policy strategy is summarised. For instance, ED mentions the need for each Member-State to define Energy Poverty and Vulnerable consumer and GEUR establish that “*the number of households in energy poverty taking into account the necessary domestic energy services needed to guarantee basic standards of living in the relevant national context, existing social policy and other relevant policies, as well as indicative Commission guidance on relevant indicators for energy poverty*” should be assessed (European Union, 2018b). Both of these cases are accomplished in the end of chapter 1 and are the first sign of how ELPCPE shows a clear orientation when defining its strategy to fight energy poverty.

Both Energy Poverty and Vulnerable Consumers are defined after explaining how the EPOV suggestions were accounted in addition to the contextualization of the Portuguese domestic sector (Residential Building Stock, Energy Consumption Energy Market and Life Conditions). The former, Energy Poverty, is presented as the inability to maintain housing with an adequate level of essential energy services, due to a combination of low income, low energy performance of housing and energy costs (own translation). The latter, Vulnerable Consumers, is defined as the domestic energy consumer in situation of energy poverty, vulnerable to energy services disconnection for health or advanced age among other reasons (own translation).

Furthermore, indicators are presented in two categories, primary and secondary (table 33), but the reason to these categories is not presented. In addition to the categories considered by ELPCPE, indicators were organised in five of the 6 different groups selected in the single instrument analysis. The code of the indicators is established by the first letter of the group, followed with the letter of the instrument (P- ELPCPE, E- ELPRE, C-PNEC) and lastly, the numeration of the indicator. Energy, Income and Dwellings are the three critical highlighted elements of Energy Poverty Issue and indicators are an example of how these elements are the backbone of the strategy.

Table 33 Indicators of ELPCE organised by group and codes. The code starts with the first letter of the group, followed with the letter of the instrument (P) and lastly, the numeration of the indicator

	Group	Code	Indicator
Primary	Temperature (T)	TP1	Population unable to keep home adequately warm
		TP2	Population in poverty situation and unable to keep home adequately warm
	Social Tariff (S)	SP3	Households with Social Electricity Tariff
		SP4	Households with Social Gas Tariff
	Income (I)	IP5	Households whose energy expenditure represents + 10% of total income
		IP6	Households in poverty situation whose energy expenditure represents + 10% of total income
Secondary	Income (I)	IP7	Population at risk of poverty
	Dwellings (D)	DP8	Population living in dwellings with problems of infiltration, humidity or rotten elements
		DP9	Population in poverty a situation and living in dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames of floor
	Temperature (T)	TP10	Population living in a dwelling not comfortably cool during summer
	Energy Efficiency (E)	EP11	Energy Performance of Buildings
	Income (I)	IP12	Population with debts to public utilities services
		IP13	Population in poverty a situation with debts to public utilities services
	Others (O)	OP14	Interruptions due consumer attributable fact
	Knowledge (K)	KP15	Global energy literacy of private consumers

Secondly, ELPCE action plan is presented. In this chapter, it was possible to observe how local measures are organized into different categories which, in turn, are linked to the guiding principles of the instrument. In total, 30 measures were presented and 7 different target groups¹⁴ were counted. The table 34 illustrates this link and summarizes the number of target groups considered by different areas of the measures. It is interest to note that *Consumers* is the far more assessed target group in the ELPCE with 25 correspondent measures and the next higher number of measures per target group is *Schools* with only 2 measures in comparison.

Table 34 ELPCE Guiding Principles, Number (#) of Measures Areas and Number (#) of measures per Target Groups

Guiding Principles	Code of Area (A)	Measures Areas	Total	Target Groups (# of measures)
Increase the energy performance of homes	AP1	Energy Efficiency	10	15 Consumers
Reinforce the conditions of access to energy services	AP1	Price Support and charges reduction	5	
Reduce energy consumption charges	AP3	Consumer Protection	8	7 Consumers, 1 Municipalities, 1 Market Agencies
Strengthen knowledge and access to information	AP4	Information, Knowledge and	7	3 Consumers, 2 Schools, 1 Professionals, 1 Local Agents

¹⁴ Target Groups were translated from the ones presented in the ELPCE tables.

on energy	Education	and 1 General
		25 Consumers
		1 Municipalities
		1 Market Agencies
		2 Schools
		1 Professionals
		1 Local Agents
		1 General
Total	30	

In addition to the measures and target groups, ELPCPE distinguishes the actors of each measure in what was considered as Responsible Actors, Co responsible Actors and Funding Actors. As can be observed on table 35 the major actors are MAAC, DGEG and ADENE ¹⁵.

Table 35 ELPCPE actors. (Acronyms identified on Annex 5)

Responsible Actors	# of measures	Co Responsible Actors	# of measures	Funding Actors	# of measures
MAAC	30	DGEG	22	PRR	8
MTSSS	5	ADENE	28	PT 2030	7
METD	3	IHRU	2	PPEC	11
MIH	1	RNAE	10	Fundo Ambiental	9
MCTES	1	Energy Agencies	11	Banca	1
MS	1	Banco Do Fomento	1	Community	7
MMEAP	1	Banca	1	State Budget	1
ME	2	ERSE	6	Non Existent	13
MF	4	Municipalities	10		
		Private	1		
		Local Agents	1		
		Market Operators	6		
		ANMP	1		
		ANAFRE	1		
		Parishes	1		
		DECO	2		
		DGC	1		
		AMA	1		
		Local Energy Agencies	1		
		DGE	2		

¹⁵ Acronyms of the ELPCPE are present on Annex 5.

DGS	1
Health Centres	1
Health Delegations	1
INE	1
Private Operators	1
IPSS	1

ELPCPE present the measures in tables which, in addition to identifying the objectives, actors, target groups and implementation period, shows how each measure affects six different indicators. In order to simplify the analysis of how the different areas of the measures affect the different indicators, table 36 shows the respective number of measures for each indicator. Accordingly, it can be seen how the instrument measures especially affect income indicators and that the energy efficiency measures are the only ones that affect all the indicators considered. This will be an important factor when analysing how the different indicators are aimed in the different instruments.

Table 36 ELPCPE number of indicators assigned per measure categories

Indicator Code	Energy Efficiency	Price Support and Charges Reduction	Consumer Protection	Information, Knowledge and Education	Total
SI1	2	5	3	1	11
ST4	3	-	-	-	3
PT1	3	-	-	-	3
SD2	4	-	-	-	4
SE5	8	-	2	2	12
SK9	2	1	3	5	11
Total	22	6	8	8	44

The guiding principles of the instrument were not only accounted for in their connection with the measures presented, but a consequence of the objectives outlined by the document. At the beginning, in the executive summary, ELPCPE outlines the following short goals:

1. Allocate 300 million euros from European Funds between 2021 and 2025 for Energy Efficiency actions in residential buildings.
2. Assign 100,000 “Efficiency vouchers” to families in situation of Energy Poverty for equipment replacement and adoption of efficient solutions in their accommodations, with an average value of 1,300 euros per voucher
3. Allocate 135 million euros to the Energy Renewal of Residential Buildings in the next 5 years.
4. Implement a system for monitoring EP in Portugal, through data collection and treatment, in a centralized and easy access way.

5. Promote the development of local structures to support and monitor families in situation of Energy Poverty.
6. Stimulate self-consumption projects and renewable energy community that integrates families in the situation of Energy Poverty.

When presenting the plan of action, fighting Energy Poverty while protecting vulnerable consumers and integrate them in an active energy and climate transition is identified as the principal goal of the ELPCE. However, the instrument also presents the achievement goals of measures:

- Strengthen national and local capacities for identification and monitoring.
- Constitute a base of work to create dynamics at national, regional and local scale, which allows to join efforts in the fight against a common cause, taking advantage of the proximity to the citizen of the local agents.
- Promote, support and monitor projects, in different scales and areas of operation, taking into account national priorities.
- Streamline pilot and innovative projects with local and regional impact, making the most of national skills and capabilities.
- Prepare the legislation, regulations and normative frameworks, constituting a framework that promotes the change of this paradigm in Portugal.
- Streamline monitoring capacity at national and local level.

There is a link between the measures presented and the goals outlined. In essence, the fight against energy poverty is seen as a way to bring more comfort to homes, more disposable income, better quality of life and better health for the consumers. Through the analysis of ELPCPE, it was possible to conclude that it is organized in a clear and consistent manner.

4.4.1.2. Estratégia Nacional de Longo Prazo para a Renovação de Edifícios

Estratégia Nacional de Longo Prazo para a Renovação dos Edifícios (ELPRE) is an instrument that results from European policies¹⁶ with a focus on the renovation of the housing stock and a climate transition. The strategy establishes the goals for the horizons of the 2030s, 2040s and 2050s, compared to the 2018 records, by reference to the entire national park of existing buildings which is presented in an extensive analysis of the built park.

Based on the focus of this work, the instrument was analysed only on how it can be articulated with the different documents analysed and on how energy poverty is portrayed and combated. Therefore, the analysis started by examining how the instrument goals were, or not, consistent with the measures

¹⁶ ELPRE was approved as part of the transposition of Directive (EU) 2018/844 of the European Parliament and of the Council, of 30 May 2018, on the energy performance of buildings and Directive 2012/27 / EU on energy efficiency (Decree-Law nº 101 - D / 2020, of 7 December), the Resolution of the Council of Ministers no. 8-A / 2021, of 3 of February.

taken. In figure 39, the translation of ELPRE's assumptions is presented, which, in turn, are the 3 main axes. It is emphasized how the improvement of living conditions entails energy poverty as one of its priorities.

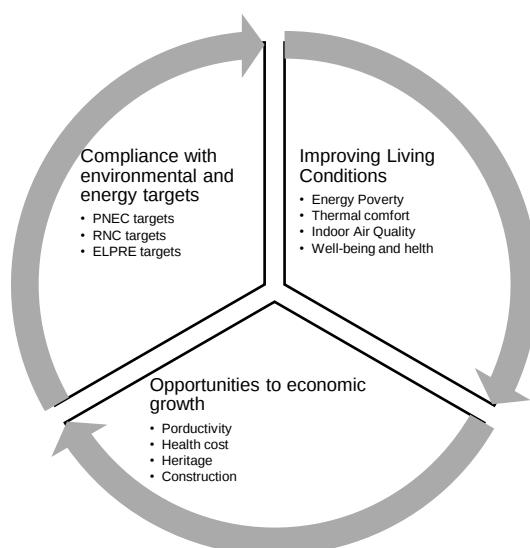


Figure 39 Assumptions that leverage ELPRE. Source: Own translation of (República Portuguesa, 2021a)

ELPRE focuses on the Energy Performance Building Directive¹⁷ (European Union Parliament & European Union Council, 2018) to establish its lines of action. These are presented together with their target groups and implementation period. Unlike the other documents, the actors and sources of financing for each action are not identified. Bearing in mind that the focus of this work was to understand the instrument's contribution to the policy mix to fight energy poverty, this analysis made it possible to immediately identify a symptom of the document's lack of consistency and comprehensiveness. The actors for the application of the measures were vaguely given as an example in some measures and the sources of financing were presented in a separate chapter of the measures in which it is not explained how these will be used to promote the measures. In consequence, it was not possible to distinguish how the different actors presented in the instrument were linked to energy poverty measures and how they contributed to the EP Policy Mix.

However, it was possible to identify the target group which each measure assessed Energy Poverty. As can be observed in table 37, four different measures packages are considered by ELPRE. These packages, in turn, are classified according to their relation to the measures' areas of action. The table 37 also makes it possible to observe how the actions presented influence the fight against energy poverty, since the package of measures to which it relates is the second best ranked in its relationship

¹⁷ Directive 2018/844, of 30 May 2018, on the energy performance of buildings

with the areas of action. The rank of the relationship between the action axis and the measures packages was defined by the ELPRE itself. The summing of the scores by measures package and action axis allows to verify how the Comfort and Energy Poverty mitigation package has the second best score, monitoring (EA7) is the best ranked action axis and its followed by four equally ranked action of axis (EA1, EA3, EA4, EA5). Overall, measures which ELPRE offers to fight Energy Poverty belongs to the package with highest rank in term of action axis and has the second highest score of all packages showing a strong sign of a consistency between the setting goals and the measures applied to fight Energy Poverty.

In turn, for a subsequent analysis of all the documents analysed, the measures established as belonging to the energy poverty package were analysed for the identified target groups. The table 38 illustrates the lines of action by code and the number of categories and measures per line of action. As would be expected considering the scope of ELPRE, the target group with the most media is *Residential (or not) Buildings*.

Table 37 ELPRE summary of Action Axis, Number (#) of Measures Areas and Number (#) of measures per Target Groups

Official Code	# Action Axis	# Measures	Target Groups (# of measures)
EA1	6	9	7 Residential (or not) Buildings, 1 Pubic Buildings, 1 Professionals
EA3	3	6	4 Residential (or not) Buildings, 1 Residential Buildings with lower performance, 2 Energy Renovation Products and Services for Buildings
EA4	1	2	1 Residential (or not) Buildings, 1 Professionals, 2 Educational Community, 1 Energy Renovation Products and Services for Buildings
EA5	1	2	2 Consumers, 2 Local Agents
EA7	1	2	2 Consumers, 1 Private Agents, 2 Public Agents, 1 Civil Society, 1 Professionals
			12 Residential (or not) Buildings
			1 Public Buildings
			3 Professionals
			1 Residential Buildings with lower performance
			3 Energy Renovation Products and Services for Buildings
			2 Educational Community
			2 Local Agents
			1 Private Agents
			2 Public Agents
			1 Civil Society
Total	12	21	

Table 38 ELPRE number of measures organised per EPBD Directive Goals, Action Axis and respective Code and Measures Package- 3 is the highest score.

Directive EPBD Goals	Official Code	ELPRE Action Axis	Measures Package				Total
			Comfort/ Energy Poverty Mitigation	Increased Energy Efficiency	Local Decarbonization	Comfort/ Increased Energy Consumption	
Creation of an environment favorable to the deep renovation of the national built park for NZEB buildings, with a view to improving their energy performance;	EA1	Building Renovation	3	3	2	-	8
Foster the intelligence of buildings, making them more efficient, safe and comfortable	EA2	Smart Buildings	-	3	1	1	5
Reinforce the role and contribution of energy certification to improve the energy performance of buildings;	EA3	Energy Certification	3	3	2	-	8
Increase the technical capacity of construction and energy professionals, aligning it with the objectives of promoting energy efficiency and decarbonization of buildings;	EA4	Training and Qualification	3	3	2	-	8
Combat energy poverty, supporting the most vulnerable families in the rehabilitation of their homes;	EA5	Combat Energy Poverty	3	2	-	3	8
To raise awareness among citizens about the energy and non-energy benefits of rehabilitation, providing them with information that enhances and facilitates the performance of interventions.	EA6	Information and Awareness	-	3	-	-	3
<i>Does not define</i>	EA7	Monitoring	3	3	3	-	9
Total			15	20	10	4	

Different types of indicators are presented at the end of the instrument as a basis for measuring the progress of the instrument. In total, 8 indicators are accounted for monitoring policies and measures to mitigate energy poverty. The indicator group that most represents the selected indicators is *Other*, appearing 4 times, as can be noticed in table 39.

Table 39 Indicators of ELPRE organised by group and codes. The code starts with the first letter of the group, followed with the letter of the instrument (E) and lastly, the numeration of the indicator.

Group	Code	Indicators
Other (O)	OE1	Number and percentage of people affected by energy poverty, by geographic location (preferably statistical subsection)
Income (I)	IE2	Proportion of household disposable income spent on energy, by geographic location (preferably statistical subsection)
Income (I)	IE3	Overdue payments of utility bills, by geographic location (preferably statistical subsection)
Dwellings (D)	DE4	Number and percentage of people living in inadequate housing conditions (including conditions of thermal discomfort), by geographic location (preferably statistical subsection)
Other (O)	OE5	Vulnerability to energy poverty Index, by geographic location (preferably statistical subsection)
Social Tariff (S)	SE6	Allocation of the social tariff: distribution by geographic location (preferably by statistical subsection) and considering the type, period of construction, size and climatic zone of the building
Other (O)	OE7	Amount attributed in energy checks, by geographic location (preferably by statistical subsection)
Other (O)	OE8	Value attributed in subsidies for replacing space heating and DHW systems with efficient systems

Despite the existence of consistency between the objectives outlined in the instrument and the measures presented, it is concluded that the document makes it difficult for comprehensiveness as to how these measures can contribute to the indicators, or vice versa. In addition, the lack of a link between actions and their responsible actors and sources of funding is a symptom of the lack of consistency in the document as it makes it difficult to understand how they can or cannot contribute to the same objective.

4.4.1.3. Plano Nacional de Energia Clima 2021-2030

*Plano Nacional Energia e Clima 2021-2030 (PNEC)*¹⁸ was developed by DGEG in articulation with as a Portuguese national plan which establishes the climate and energy policy goals. In this instrument, national targets for reducing greenhouse gas emissions, including sectoral ones, targets for

¹⁸ PNEC was approved by Resolution of the Council of Ministers No. 53/2020, of 10 July, and fits into the obligations arising from Regulation (EU) 2018/1999 of the European Parliament and of the Council, of 11 December 2018, on the Governance of the Energy Union and Climate Action and will be the main instrument of energy and climate policy for the decade 2021-2030.

incorporating renewable energy and energy efficiency are described. Furthermore, the 58 lines of action and 206 measures to be adopted for the decarbonisation of society and for the energy transition is presented in articulation with the Roadmap for Carbon Neutrality 2050 (República Portuguesa, 2019c).

Two different versions were considered while collecting the information: the one published in the official site of Public Consultation (República Portuguesa, 2019b) and the English Version Published in the EU official website (República Portuguesa, 2019a). The first defined the indicators which should be used to monitor the proposed measures which were here considered as the Energy Poverty indicators that PNEC proposed. The latter is the official document of PNEC which follows the framework proposed in the GEUR for National Energy and Climate Plans in EU.

PNEC characterizes the existing situation in Portugal in terms of Energy and Climate, covering five dimensions: decarbonisation, energy efficiency, security of supply, internal energy market and research, innovation and competitiveness. Moreover, national contributions and main lines of action were planned in accordance with the fulfilment of the Union's different global commitments, including in terms of reducing greenhouse gas emissions, renewable energies, energy efficiency and interconnections.

Table 40 illustrates the evaluation of the relationship between the national goals and the dimensions defined in PNEC. As can be observed, three national goals obtain the same highest score (C1, C2, C3) and one dimensions is highlighted with 33 points (more than the double of the lowest score, Internal Market). This aims to understand how PNEC recognises its dedication to the different goals presented and how the energy poverty measures are or not assigned with the highest score ones. It is important to note that the score of the relations were defined by the PNEC itself, making it a reliable source of information to analyse these characteristics.

Table 40 Relationship Evaluation between National Goals and the dimensions of PNEC- 5 is the highest score. Source: adapted from PNEC

Code	National Goals	Dimensions					Total
		Decarbonisation	Energy Efficiency	Energy Security	Internal Market	Research, innovation and competitiveness	
C1	Decarbonize the National Economy	5	3	2	2	4	16
C2	Put Energy Efficiency First	5	5	2	-	4	16
C3	Reinforce the focus on renewable energies and reduce the country's energy	5	-	4	3	4	16

	dependence						
C4	Ensure supply security	2	-	5	3	3	13
C5	Promote Sustainable Mobility	4	4	1	1	3	13
C6	Promote sustainable agriculture and promote carbon capture	4	2	-	-	3	9
C7	Develop innovative and competitive industry	4	3	-	-	4	11
C8	Ensure a fair, democratic and cohesive transition	4	3	1	3	1	12
Total		33	20	15	12	26	

Energy Poverty is considered in this instrument as an important element for the climate and energy transition in Portugal. It is noted that “*Situations of energy poverty must be identified and avoided through measures aimed mainly at urban rehabilitation, promoting energy efficiency in buildings, focusing mainly on insulation measures, and reducing dependence on fossil fuels*”. It is also added the importance of “*decentralized production of electricity based on renewable energy communities and the valorisation of collective systems*” can contribute to fight energy poverty since they “*allow to reduce energy costs and unburden families*” (own translation) (República Portuguesa, 2019b).

Bearing in mind that instruments should consider its contribution to fight Energy Poverty, fourteen measures (table 41) were identified. It is important to note that the measures which were considered were not only the ones presented in the framework of PNEC in ELPCPE, which only considered the ones under the C8 goal, but also those which mention Energy Poverty and were compliant with the general type identified in ELPCPE and ELPRE. Consequently, measures from C1 and C3 were also identified in the most recent version of PNEC published in the official site of European Union (European Union, 2021).

They are organised under the national goal C8 and its respective second line of action: *combat energy poverty and improve protection instruments to vulnerable customers*. The latter reinforces the aim for an energy transition process in a fair, cohesive and inclusive way, and which does not accentuate energy poverty but helps mitigate it.

In addition to the measures of PNEC, table 41 also illustrate their respective target groups and actors. The former was defined by the interpretation of the measures descriptions and the latter are defined by

the instrument. It is interesting to note that *Consumers* is the most recurrent target group, appearing 4 times and is the only one that appears in more than one measure.

Table 41 PNEC summary of the number (#) of Target Groups per measures and actors

Official Code	Measures (M)	(#) Target Group	Responsible Actors	Funding Actors
1.3.1	Promote rehabilitation as the main form of intervention in building stock and urban development	1 Buildings	MAAC MIH GRA GRM	IFRRU Efficient House 2020 FNRE The Rehabilitate to Rent Program
1.3.2	Promote sustainable techniques in construction and sustainable buildings	1 Buildings		
1.3.3	Promote the electrification of buildings accompanied by an increased use of renewables	1 Buildings		
3.2.1.	Promote distributed production and self-generation of energy from renewable sources, removing obstacles for their dissemination	1 Consumers	MAAC GRM GRA DGEG ERSE Madeira Electricity Company ADENE	EEF FAI Community Funds
3.2.2	Promote the creation and development of energy communities	1 Consumers		
3.2.3	Promote programs to support the establishment of energy communities in partnership with municipalities	1 Municipalities		
3.2.4	Reinforce the Electronic Production Units Registration System	1 Consumers		
3.2.5.	Implement an electronic information portal on distributed production, self-generation and energy communities	1 Consumers		
8.2.1	Promote a long-term strategy to combat energy poverty	1 General	MAAC METD MTSS GRA DGEG RNAE Energy Agencies	EEF FAI EF
8.2.2	Establish a national system for assessing and monitoring energy poverty, including the number of households in energy poverty	1 Consumers		
8.2.3	Proceed with mechanisms to protect vulnerable customers and study the introduction of new mechanisms	1 Consumers		
8.2.4	Develop energy efficiency promotion and renewable energy integration programs to mitigate energy poverty	1 Municipalities 1 Consumers		
8.2.5	Promote and support local strategies to combat energy poverty	1 Local Agents		
8.2.6	Disseminate information to mitigate energy poverty	1 Consumers		

Measures combat energy poverty and improve instruments for protecting vulnerable customers. According to PNEC, a long-term strategy would be developed (MC1) to obtain a diagnosis and characterization of the problem, developing monitoring indicators, monitoring strategies, establishing objectives for the reduction of energy poverty in the medium and long term, at national, regional and local scale, and propose specific measures to achieve these objectives, and the respective forms of financing. This long-term strategy corresponds to the ELPCE analysed in this dissertation.

Indicators are presented under the C8 description. Although these indicators are applied not only to monitor energy poverty mitigation measures but also the other line of action under the C8 goal, their usage was strongly supported by the process of climate and energy transition to mitigate EP. Therefore, all indicators were accounted as Energy Poverty and organised under their respective group as can be seen in table 42.

Table 42 Indicators of PNEC organised by group and codes. The code starts with the first letter of the group, followed with the letter of the instrument (C) and lastly, the numeration of the indicator

Group	Code	Indicator
Social Tariff (S)	SC1	Number of beneficiaries of the Social Energy Tariff
Income (I)	IC2	Weight of energy bills in the domestic budget
Temperature (T)	TC3	Inability to keep homes warm during winter
Temperature (T)	TC4	Inability to keep homes cool during the summer
Dwellings (D)	DC5	Dwellings with high levels of humidity and leaks in the roofs.
Other (O)	OC6	Creating green jobs
Other (O)	OC7	Number of green patents

4.4.1.4. Plano de Recuperação e Resiliência

Plano de Recuperação e Resiliência (PRR)¹⁹ is a program of national application with the shortest period of execution of the national instruments here analysed- until 2026. The instrument aims to implement a set of reforms and investments that will allow Portugal to return to sustained economic growth, ensuring the exit from the pandemic crisis and guaranteeing a resilient future for our country. PRR is structured in three dimensions: Resilience, Climate Transition and Digital Transition.

In an overview of the longest instrument with more than 300 pages, it was crucial to understand its organisation and summarise the most important information which could support the PRR contribution to Energy Poverty Policy Mix.

¹⁹ PRR was submitted to the European Commission on April 22, 2021, under the Recovery and Resilience Mechanism, launched by the European Commission, on February 12, 2021.

First, the goals of the documents were organised in table 43. There is a strong preoccupation on the achievement of European Union recommendations and articulation with EU six pillars and flagship initiatives. The instrument develops 2 chapters for these goals and, in the second chapter, *Promotion of Opportunities Equality and Gender Equality* and *Intern and External Coherence* are added as the general goals of PRR.

Table 43 PRR Goals

General Goals	Summary	Description
Articulation with European Semester	Country-specific recommendations (REP) for Portugal within the European Semester	REP 1 Guarantee financial and institutional resilience, supporting the fight against the pandemic without compromising fiscal sustainability in the medium term;
		REP 2 Promote skills and qualifications, support quality employment and reinforce social protection;
		REP 3 Foster public and private investment, with a particular focus on the dual digital and climate transition
		REP 4 Improve circumstances conditions for companies and citizens
Alignment with European Pillars	Align the use of the financial resources of the Recovery and Resilience Mechanism with European priorities which defines six Relevant European Pillars	1 Green transition
		2 Digital transformation
		3 Smart, sustainable, and inclusive growth, including economic cohesion, employment, productivity, competitiveness, research, development and innovation, and a well-functioning single market with strong small and medium-sized enterprises
		4 Social and territorial cohesion
		5 Health and Economic resilience, social and institutional, to increase the capacity to react and prepare for crises
		6 Policies for the next generation, children and youth, including education and skills.
Alignment with Flagships Initiatives	Annual Sustainable Growth Strategy 2021, published in European Semester framework	1 Strengthening energy resilience
		2 Renovation of buildings
		3 Recharging and refueling
		4 Interconnection
		5 Modernization
		6 Expansion
		7 Requalification and improvement of skills
Promotion of Opportunities Equality and Gender Equality	Definition of policies that allow to respond not only to the conjunctural inequality, but also to act on factors structural factors of inequality.	
Intern and External Coherence	PRR seeks alignment with the Portugal 2030 Strategy, as well as with the relevant sectoral strategic reference framework for its development.	

Second, the three dimensions were overviewed to deploy how the proposed reforms, investments or goals could foment the fight of Energy Poverty.

The **Resilience Dimension** concentrates 61% of the amount of PRR grants and is the most transversal thematic area, interconnecting and contributing to the achievement of the investment goals proposed by the European Commission in the six Relevant Policy Pillars of the EU. Centred on people and on the development of the territory, the Resilience Dimension includes nine components such as Health, Social Responses, Housing, Innovation, Infrastructure, Qualifications and Skills, among others. These nine components result in 20 reforms, carried out through 43 investments.

The **Climate Transition Dimension** constitutes an ambitious sustainability agenda, and a financing tranche will be applied which corresponds to 18% of the total PRR grants. This dimension includes a total of 6 components, which will result in 8 reforms implemented through 17 investments. The sea, sustainable mobility, industry decarbonization, bioeconomy, energy efficiency in buildings and renewable energy are the 6 components. o, accelerating the transition to the use of clean and renewable energy, developing the circular economy and changing the paradigm of mobility, taking into account the needs to preserve the future of new generations. On the other hand, the strong investment in energy efficiency will lead to a qualitative leap for the Portuguese population, strongly reducing the situations of energy poverty, which, at present, affect thousands of families.

The **Digital Transition Dimension** concentrates 15% of the global amount of PRR grants and develops through 5 components. Under the 5 components, 7 reforms are adopted, and 17 investments implemented. The goal of this dimension is presented as pretending to answer the need for effective digital structures to ensure the dematerialization of learning, transactions and processes and that enable remote work, consolidating in a way the transformation that is already underway in this area, accelerated by the pandemic, is satisfactory.

After this overview, it was concluded that the *Climate Transition Dimension* was the one with the biggest contribution to fight Energy Poverty. However, it was also noted that Resilience Dimension also presents two of the nine components which can indirectly affect the energy Poverty fight: dwellings and social answers. This observation is also supported by the ELPCPE presentation of PRR. However, it is important to note that while the ELPCPE indicate 3 components of the PRR, the most recent version of the PRR assembled the previous component four (Elimination of Poverty Grants in Metropolitan Areas) which adopted the National Strategy to Fight Poverty in the current component 2 of Social Answers.

This plan does not aim to establish the measures and their respective indicators, actors and target groups. The indicators presented are to monitor the implementation of the PRR and are attributed to each component of each dimension. However, these types of indicators do not correspond with the ones used to monitor EP. Nonetheless, it is important to note how the component 13 of Climate Transition Dimension presents **ELPRE and ELPCPE as two of the three reforms to be adopted**. This component aims to rehabilitate and make buildings more energy efficient, enhancing the achievement of multiple objectives, providing countless social, environmental and economic benefits for people and companies. Furthermore, this is the only component which directly mention and

establishes energy poverty as one of the multiple goals and it foresees as investments, 300 M € for energy efficiency in residential buildings, 240 M € for energy efficiency in buildings of the Central Public Administration and 70 M € for energy efficiency in service buildings.

On the whole, PRR is a Plan which aims to establish guides for the other reforms to be adopted and investments to be implemented. Energy Poverty is not the focus of the Plan but one of the multiple goals assessed. The complexity of the instrument and its divergence from the topic of this dissertation limits how conclusions could be outlined about its consistency and comprehensiveness.

On the one hand, consistency needed to be interpreted how the goals of PRR were in concordance with the ones whose components were presented. In this case, it was observed how the climate transition dimension mentions the assignment of 100,000 vouchers to support efficient energy solutions for households in an energy poverty situation but does not specify the criteria, value or how the target group should be defined, or which reform was assigned to specify it. These shows how the Plan lacks the consistency between the present reforms and their relations to the goals of the plan. However, it is important to note that this measure is specified in the ELPCPE as the second measure of the action area Energy Efficiency (AP1). The assignment to ELPCPE to define the criteria of application of these vouchers is not clear in the PRR. This shows that the PRR could be clearer in its measures for Energy Poverty which would be positive to the consistency and comprehensiveness of the plan.

On the other hand, comprehensiveness was adapted to how PRR was overall able to clearly indicate Energy Poverty characteristics and define a clear vision. In this case it was noted the lack of justification of how the reforms and investments could generate the accomplishment of the goals. The structure of the plan permitted to easily navigate through the dimensions and understand the value of investments assigned to each component. However, the link of the components to the general goals of the plan was not clear.

4.4.1.5. Clean Energy for All Europeans Package

The Clean energy for all Europeans package (CEP) was developed by the European Union as the latest update of its energy policy framework and to deliver the Paris Agreement commitments for reducing greenhouse gas emissions (European Union, 2019a; Paris Agreement, 2015). In total, eight legislative acts contribute to five key dimensions (table 44).

Table 44 CEP 8 legislative acts: dimensions and summary

Code		Official Name	Dimension	Summary
EPBD	Energy Performance in Buildings	Directive (EU) 2018/844	Energy performance in buildings	.Provisions for better and more energy-efficient buildings
		(European Union Parliament & European Union Council, 2018)		.Amend Directive 2010/31/EU on the energy

				performance of buildings and Directive 2012/27/EU on energy efficiency . Establish each Member State to develop Long-term renovation strategy
RED	Renewable Energy	Directive (EU) 2018/2001 (European Union, 2018a)	Renewable energy	.Sets a target for renewable energy sources (RES) .Provisions for mainstreaming RES in the transport and heating and cooling sectors.
EED	Energy Efficiency (EED)	Directive (EU) 2018/2002 (European Parliament & European Union Council, 2012)	Energy efficiency	.Sets a target for energy efficiency .Provisions extending energy savings obligation and heat meters remote reading.
GEUR	Governance of the Energy Union	Regulation (EU) 2018/1999 (European Union, 2018b)	Governance regulation	.Sets a new governance system for the Energy Union .Sets Each Member State to establish a National Energy and Climate Plan .Outlines how Member States should achieve its respective targets.
ERD	Electricity Regulation	Regulation (EU) 2019/943 (Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the Internal Market for Electricity, 2019)		.Sets principles for the internal EU electricity market .Focuses on the wholesale market and network operation. .Provisions that affect electricity network codes and guidelines. .Sets a new bidding zone review process
ED	Electricity Directive	Directive (EU) 2019/944 (European Union, 2019b)	Electricity Market Design	.Rules for the generation, transmission, distribution, supply and storage of electricity .Consumer empowerment and protection aspects .Provisions for distribution system operators' flexibility procurement
RPR	Risk Preparedness	Regulation (EU) 2019/941 (Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the Internal Market for Electricity,		.Requires Member States to prepare plans on how to deal with potential future electricity crises

		2019)	
ACER	Agency for the Cooperation of Energy Regulators	Regulation (EU) 2019/942 (European Union, 2019c)	.Updates the role and functioning of ACER .Increases Acer competence in cross-border cooperation

The primary goal of the **Energy Performance of Buildings Directive** is to make the energy efficiency of buildings transparent through their energy performance certificates which shows the rating of buildings and recommendations on how to improve its efficiency. The main points of the directive are:

- Path towards a low and zero-emission building stock in the EU by 2050 underpinned by national roadmaps to decarbonise buildings.
- Encouraging the use of smart technologies to ensure buildings operate efficiently.
- Supporting the rollout of the infrastructure for e-mobility in all buildings
- Smart readiness indicator which will measure buildings' capacity to use new technologies and electronic systems to adapt to the needs of the consumer, optimise its operation and interact with the grid.
- Integrating and substantially strengthening long-term building renovation strategies.
- Mobilising public and private financing and investment
- Combatting energy poverty and reducing household energy bills through long-term building renovation strategies²⁰

According to EPBD, the **establishment of the long-term renovation strategy** by each Member State aims to “*to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings*”. Furthermore, energy poverty should be considered in the strategy by the “*overview of policies and actions to target the worst performing segments of the national building stock, split-incentive dilemmas and market failures, and an outline of relevant national actions*”. The Portuguese long-term strategy for renovation was presented in the instrument here analysed: ELPRE.

The **Renewable Energy Directive** establishes the targets for renewable energy sources in final energy consumption. The key elements of the directive are:

- create an enabling environment to accelerate public and private investment in innovation and modernisation.
- Establishes guiding principles on financial support schemes for renewable energy sources, renewable energy self-consumption, energy communities and district heating.
- Enhance mechanisms for cross-border cooperation, simplify administrative processes, strengthen the sustainability and greenhouse gas emissions-savings criteria for biofuels, and

²⁰ Article 2 of EPBD

mainstream the use of renewable energy sources in the transport sector and in the heating and cooling sector.

The **Energy Efficiency Directive (EED)** aims to speed the renovation of existing buildings while helping to decarbonise the European Housing Stock and requires each Member State to take account of the need to reduce energy poverty in the context of their energy efficiency obligations. Under the topic of energy poverty, 3 articles are highlighted:

- **Article 3** defines that each Member State shall “*set an indicative national energy efficiency target, based on either primary or final energy consumption, primary or final energy savings, or energy intensity*”.
- **Article 4** requires member states to “*establish a long-term strategy for mobilising investment in the renovation of the national stock of residential and commercial buildings, both public and private*”. This long-term strategy in Portugal is the ELPRE here analysed.
- **Article 7** requires:
 - Member States shall describe in their integrated national energy and climate plans the calculation of the amount of energy savings. The Portuguese national energy and climate plan is the PNEC here analysed.
 - The design of policy measures to not only fulfil the energy savings obligation but also include information about the outcome of measures to alleviate energy poverty in the context in the integrated national energy and climate progress reports.

The **Governance of the Energy Union Regulation** sets common rules for planning, reporting and monitoring and ensures their synchronization with the Paris Agreement cycles. Five dimensions of the Energy Union²¹ are applied and the following information is highlighted:

- Establishes each Member State to develop their national energy and climate plans (Portuguese PNEC) and its framework with five dimensions.
- Requires the development of national long-term strategies (ELPRE and ELPCPE) to ensure consistency with the national energy and climate plans (PNEC)
- Establishes that the number of households in energy poverty should be assessed by the national energy and climate plans (PNEC)
- If a significant number of households in energy poverty is calculated, an indicative objective to reduce energy poverty should be included in their national energy and climate plans (PNEC)

The **Electricity Regulation** provides a framework for the further integration of renewable energy into the electricity market, sets out new rules on bidding zones and cross-zonal capacity allocation and reinforces the role of the market in providing price signals for investment. It works in combination with the ED to introduce new limit new limit for powerplants eligible to receive subsidies as capacity and to put the consumers at the centre of the clean energy transition while protecting them. This regulation does not mention the national instruments here analysed nor vice-versa.

²¹ Energy Union is an EU strategy published in 2015 to which Clean Energy Package contributes to. The five dimensions of it are: (a) energy security; (b) internal energy market; (c) energy efficiency; (d) decarbonisation; and (e) research, innovation, and competitiveness.

The **Electricity Directive** aims to create integrated competitive, consumer-centred, flexible, fair and transparent electricity markets in the EU. The rules to achieve its aim is developed by key points: (1) Customer rights, (2) Billing, (3) Aggregators, (4) Citizen energy communities, (5) Access to data and interoperability, (6) Electromobility, (7) Distribution system operators, (8) Transmission system operators and (9) National energy regulators. Under the scope of Energy Poverty, the following points are noted:

- Community energy can advance energy efficiency at household level and help fight energy poverty through reduced consumption and lower supply tariffs.
- Under the Article 28 Member States are asked to define the concept of vulnerable customers “*which may refer to energy poverty and, inter alia, to the prohibition of disconnection of electricity to such customers in critical time vulnerable costumers*”. Furthermore, it is specified how the definition should be developed and how measures could be applied to protect them.
- Article 29 it is established that when Member States assess the number of households in energy poverty and the criteria used should be published. It is also added that the EU Commission should establish the guidance to de definition of the ‘significant number’ of households in EP.

The **Risk Preparedness Regulation** aims to define rules for the cooperation between the EU countries and their coordination in a spirit of solidarity. It is established common provisions for risk assessment, risk preparedness plans, managing electricity crises, evaluation and monitoring. The following information is highlighted on how RPR:

- Requires each Member State to prepare plans for how to deal with potential future electricity crises.
- Requires the use of common methods to identify all possible electricity crisis scenarios at national and regional levels and then prepare risk preparedness plans based on these scenarios.
- Establishes a new framework for a more systematic monitoring of security of supply issues via the Electricity Coordination Group.

The **Agency for the Cooperation of Energy Regulators** was established, under the Regulation (EU) 2019/942, to assist national regulatory authorities in performing their regulatory function at European level and, where necessary, coordinates their work. It aims to establish high-quality common regulatory and supervisory practices to help the single European market in gas and electricity to function properly. The following competences of ACER are highlighted:

- Coordinate the work of national regulatory authorities.
- Help formulate European network rules.
- Advise European institutions on issues relating to electricity and natural gas.
- Monitor the internal markets in electricity and natural gas and reports on its findings.
- Monitor wholesale energy markets to detect and deter market abuse.

In conclusion, the CEP is a mix of instruments which aims to develop the rules and a framework for transition from fuel fossils to clean energy. The different legislative acts work under five key dimensions to help member states to develop their own contributions to this path. Energy Poverty is directly mentioned in five (EPBD, RED, EED, GEUR, ED) of the eight legislative acts but there is a common contribution in its fight since the instruments of the package operate together within the same policy strategy. Moreover, national energy climate plans and the long-term strategies are asked for submission under the GEUR, and different directives define rules which contribute to their development, such as EPBD and EED. There is a consistent vision of the consumer at the centre of the energy transition and the legislative acts contribute to this vision by establishing, for example, the need for vulnerable customers by the ED or the propose by the EPBD to use smart readiness indicator which aims electronic systems to adapt to the needs of the consumer.

Finally, in a note of the comprehensiveness of the CEP, European Union has a special segment of its website²² on CEP which helps navigate through the different legislative acts. However, it is not easy to comprehend how each instrument interact with each other nor what exactly are the goals of the CEP. For the single instrument analysis, it was needed to read each instrument to overview how they contributed to the energy transition, but it was needed an exhaustive work and an efficient organisation methodology to highlight how energy poverty was covered by each instrument.

4.4.1.6. Renovation Wave

The **Renovation Wave** is a European strategy to improve the energy performance of buildings. Five key principles are presented:

1. Decarbonisation and integration of renewables
2. Lifecycle thinking and circularity.
3. High health and environmental standards
4. Tackling the twin challenges of the green and digital transitions together.
5. Respect for aesthetics and architectural quality

²² https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en#electricity-market-design
Retrieved May 30th 2021

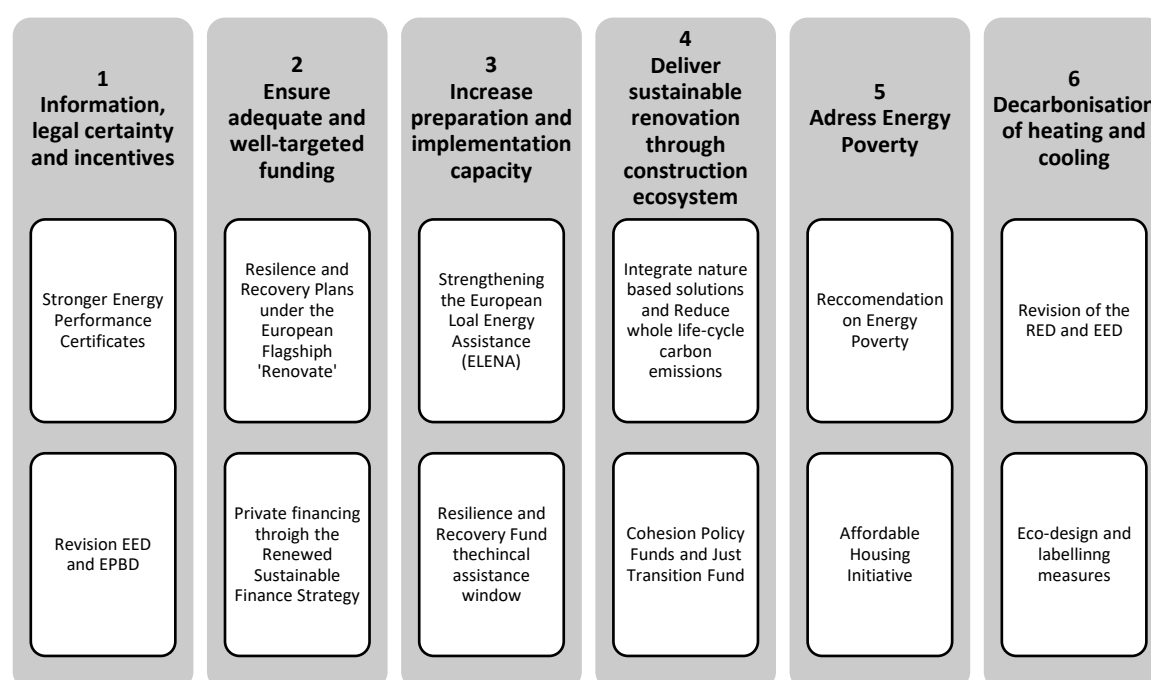


Figure 40 RW areas of Intervention and their respective lead actions

In the RW six 6 areas of intervention are considered to enable a step-change renovation. As can be observed in figure 40, the lead actions of RW involves the revision of EED, EPBD and RED from the Clean Energy for All Europeans Package. Furthermore, Energy Poverty is specially taken into account with a proposition of a Recommendation and Initiative to address it. In addition to the actions presented in figure 40, ensuring accessible and well-targeted funding through Flagship Initiatives in the Recovery and Resilience Facility under NextGenerationEU, new green jobs, expanding the market for sustainable construction products and services, creating a New European Bauhaus, integrate renewable and digital solutions and create zero-energy districts are other examples of the measures proposed in this strategy.

Energy Poverty is also mentioned under the *“integrated, participatory and neighbourhood based approach at the heart of the renovation wave”* segment since it is defended that energy communities help mitigate energy poverty by giving the most vulnerable citizens tools to generate, consume, store and sell energy. Furthermore, the RED and EPBD revision is mentioned in support of this vision.

After presenting the measures of the strategy, it is mentioned that tackling energy poverty and worst-performing buildings is one area which deserve special attention in conjunction with renovating public buildings and decarbonising heating and cooling. The following measures are proposed to tackle energy poverty:

- Minimum energy performance standards coupled with financing that limit the monthly net expenditure of the inhabitants.
- Expand the use of ESCOs and energy performance contracts.

- Use Recommendation on Energy Poverty proposed by RW in parallel with the CEP which establish national energy and climate plans and long-term renovation strategies to identify swellings of people at risk of energy poverty and consequently develop strategies to their renovation.
- The EU Building Stock Observatory, the EPOV, the Horizon Europe Mission on Cities and the EU Covenant of Mayors Office can assist Member States to address energy poverty.
- Develop a Communication on the Long-Term Vision for Rural Areas by the EU Commission
- Use of standardised industrial solutions applied as part of a comprehensive renovation package.
- Social enterprises as important partners in tackling energy poverty

Renovation Wave strategy aims to green the building stocks of EU while creating green jobs and embracing energy efficiency in its core. Energy poverty is further taken into account and different measures are presented to tackle it. In this case, there is a reinforcement to use the already existent policy strategy to tackle EP and a new recommendation is proposed. Furthermore, three directives from the CEP are aimed for revision under this strategy.

In conclusion, the strategy of RW is clear and consistent with their defined goals and EU discourse. The organisation of the instrument makes is simpler to comprehend the goals of the strategy and general measures proposed in its different dimensions. On a side note, the RW does not establish the indicators and target groups to energy poverty mitigation but suggest how Member States can be helped in their definition in their national instruments.

4.4.1.7. European Climate Law

The **European Climate Law (ECL)** proposal for regulation seeks to establish a framework for achieving climate neutrality which was set as a goal under the European Green Deal. Setting a climate-neutrality objective, adaptation to climate change, assessment of EU and National measures and amending the GEUR are the different aims of the ECL. Furthermore, the provisional agreement in April 2021 by the European Parliament and the Council sets that the ECL will include:

- Target the reduction of net emissions
- Proposes a more ambitious LULUCF regulation by the EU Commission.
- a process for setting a 2040 climate target, taking into account an indicative greenhouse gas budget for 2030-2050 to be published by the Commission.
- Commitment to negative emissions
- Establishes the European Scientific Advisory Board on Climate Change for independent scientific advice.
- Stronger provisions on adaptation to climate change.
- Strong coherence across Union policies with the climate neutrality objective.
- a commitment to engage with sectors to prepare sector-specific roadmaps charting the path to climate neutrality in different areas of the economy.

In the official documentation of proposal to ECL, the amendment of GEURD takes the major focus of how ECL will be established. With this amendment, the national plans developed under the GEURD (PNEC, ELPCPE and ELPRE) will consider a higher target previously settled by Article 2(1) of GEURD -Article 2(3) of ECL proposal- and their consistency should be assessed by 30 September 2023 and every 5 years- Article 5 and 6 of ECL. The ECL proposal ends with the amendment of the GEURD proposal- Article 10.

4.4.1.8. Gabinete de Aconselhamento Energético, Just a Change and Habitação A+

The three selected initiatives were analysed based on the public information provided in their respective website or other sources. The information offered by each instrument did not specify the defined information to be collected in the Single Instrument Analysis and, for this reason, their contribution to the Energy Poverty fight will be observed together and explained in this segment.

The ***Gabinete de Aconselhamento Energético (GAE)*** is an activity funded by the EU's H2020 program in the scope of Solutions to Tackle Energy Poverty (STEP) project. The Portuguese Association for Consumer Protection (DECO) created an office team of 35 technicians prepared to inform and help the consumers with information to improve the energy efficiency of their dwellings, manage their consumption, understand the functioning of the energy market, as well as resorting to support mechanisms in situations of energy. Two main goals are identified by DECO:

- Support consumers in situations of energy poverty to manage their energy consumption and improve their standard of living, helping them to find the most appropriate solutions, namely with regard to existing support mechanisms.
- Advise consumers on more efficient energy consumption, clarifying how this concern can help them save, improve their health and well-being and contribute to the energy transition.

The consumers can schedule an appointment with the DECO GAE by contacting the office through the contacts available on its website.

Just a Change Association (JAC) (Just a Change, 2021) is a social non-governmental organization created in 2010 which mobilizes volunteers to work on the rehabilitation of houses in precarious conservation states. According to the official declaration on the Social Security (República Portuguesa, 2017), the main goal of JAC is to promote decent housing and the social and community integration of families and people in need by:

- sensitize society, especially the youth, to the social importance of volunteering and commitment to society, by developing voluntary initiatives.
- stimulate the creativity and artistic vein of young people, organizing events in which they can exhibit their work and raise funds for the Association.
- Awareness of society conscience to the existent and latent problems to happen in the near future, whose resolution is in charge of the help and good will of all.

- advocate for a mindset and attitude that respects and promotes the fundamental values of the human person.
- Awareness of social responsibility within companies, inter alia, construction companies

The association promotes publications under the vulnerable population housing problems topic and collaborates with local organizations to screen, mobilize renovate and follow up housing poverty. Until 2020, the association renovated 237 homes and 65 social institutions under volunteer scheme across Portugal. In total, more than 5000 volunteers and 4500 beneficiaries were recorded (Just a Change, 2020). Furthermore, JAC recognises its impact in the energy poverty fight by improving the dwellings efficiency in their renovations. Since 2018, EDP is the principal partner of JAC. Under this partnership, in 2020, 22 houses and 2 social institutions were renovated, and it was possible to:

- Mobilize 37 EDP employees for voluntary work on site and skills volunteering -195 hours of volunteering.
- Emit 26 energy certificates of the rehabilitated houses, to support and guide the energy rehabilitation to be carried out in homes.
- Installation of a photovoltaic solar system for self-consumption.
- Installation of 13 energy-efficient equipment.
- Increase energy level rating after the joint intervention in 65% of the houses analysed.

Projeto Habitação A+ is a Porto Energy Agency (AdEPorto) partnership with FEUP which aims to support and sensitize citizens to actions aimed at reducing energy and water consumption without prejudice to comfort conditions by use of equipment and measures implementation for housing improvement. The project has already been carried out in three Portuguese Municipalities and in a total of 1188 of the dwellings, 409 dwellings and 409 inquiries were carried out. The surveys carried out include:

- Survey the type of glazing and shading.
- Survey of electricity, natural gas and water contracts and respective actual consumption.
- Measurement of Temperature and Relative Humidity in all divisions of the houses analyzed.
- Measurement of Indoor Air Quality.
- Survey of equipment used in the home and respective times of use, such as kitchen, electrical and electronic, heating or cooling equipment, among others.
- Survey of some consumption habits and tips for improvement.
- Analysis of thermal comfort indicators.

The final aim of the project is to provide a personalized report for their dwelling and household, with suggestions for improvement. Monitoring visits are planned after the intervention in order to understand the impact of the project in terms of the application of the suggested measures. In addition to the interventions a *Guide to Good Practices in the Use of Energy and Water* was developed by the AdePorto.

A Dissertation developed by Cátia Costa in 2017, concerns the application of Habitação A+ project to the thermal comfort and water and energy consumption in dwellings. In this dissertation, the author

further explains how the surveys and measurements on the houses took place, the development of the guide and energy poverty is considered in the terms of the thermal comfort and energy consumption analysed in the dissertation. It was also possible to acknowledge that the project was launched in 2017 and social housing was the target group during the pilot phase. The project goals identified by the author are consistent with the same previously mentioned (Costa, 2017).

In summary, three different types of initiatives were analysed. The indicators used to assess energy poverty were not specified by the elements analysed of the initiatives, but it was possible to note that there is a strong and common vision about tackling energy poverty through energy efficiency of the dwellings. GAE and *Habitação A+* focus on helping the consumer to decrease their energy consumption by providing information measures and JAC, in addition to help the consumers, combat energy poverty through house renovations. These initiatives are developed individually.

4.4.2. INSTRUMENTS INTERACTIONS ANALYSIS

After collecting the individual information of each instrument, a revision was done to contemplate the need for further combination of instruments to justify the categorization of the interactions. As was established by the framework for interaction analysis, the instruments interactions were categorized by Types, Dimensions, Forms and Combinations.

First, it was observed that three national instruments had a correlation between them and an analysis by the CEP supported this observation. The PNEC was developed under the CEP, more specifically, according to chapter 2 of the GEURD (figure 41). In this regulation, the deadlines, structure, objectives and target groups are established, which the document must constitute, in addition to Annex I, which defines the PNEC framework. In addition, it is said that the strategy must be developed in an integrated manner to contribute to the objectives outlined in the PNEC and Annex IV sets out a framework for the strategies. Long-term renewal strategies, in this case, ELPRE in Portuguese context, are mentioned directly in the body of the text, unlike ELPCPE. However, ELPCPE recognizes its contribution to the drafting of the strategy within its European framework.

Then, still within the CEP and with accounting the interaction between different dimensions of the policy mix, it was possible to perceive the contribution of EPBD to the definition of ELPRE. This appears to amend Directive 2010/31 / EU and Directive 2012/27 / EU, requiring *“a long-term renovation strategy to support the renovation of the national park of residential and non-residential buildings, public and private, in a real estate park highly energy-efficient and decarbonized by 2050”* in article 1 and continues with the definition of the information that the strategy must contemplate.

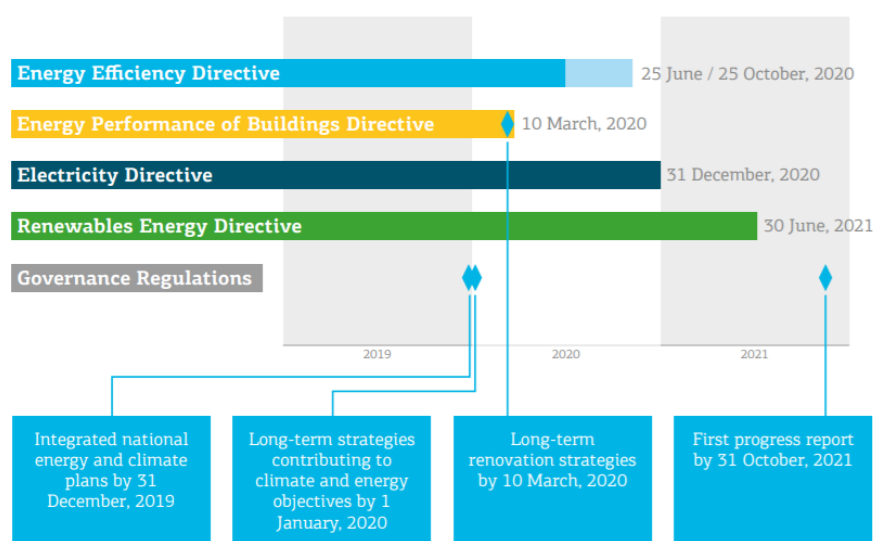


Figure 41 CEP implementation timeline and highlighted information. Source: (STEP, 2019)

After justifying the direct interaction between EPBD and GEUR within the scope of the CEP with the national instruments analysed in this dissertation, we proceeded to analyse the rest of the CEP legislation. In order to facilitate the analysis, the mentions of national instruments to CEP legislation have been tabulated (table 45). As can be seen, all national instruments mentioned two CEP legislation: EPBD and GEUR. Since it was only necessary to understand how the PRR interacted with these two legislations, the review of the PRR allowed us to conclude that this legislation did not directly affect the framework of the PRR, but rather the ELPRE, which is one of the proposals of this plan.

Table 45 CEP legislative acts mentioned in National Instruments

CEP	National Instruments			
	ELPCPE	ELPRE	PNEC	PRR
EPBD	✓	✓	✓	✓
RED	✗	✗	✓	✗
EED	✗	✓	✓	✗
GEUR	✓	✓	✓	✓
ERD	✗	✗	✗	✗
ED	✓	✗	✗	✗
RPR	✗	✗	✓	✗
ACER	✗	✗	✗	✗

Then, the RED, EED, ED and RPR CEP interaction was analysed by national instruments. It was possible to ascertain that:

- PNEC mentions RED when explaining that the goals established under article 23 (1) and in measure 3.2.2 *will not be reached. Promote the creation and development of energy communities* that refer to the framework of article 18 of the RED.
- PNEC establish the measure 2.4.2. *Introduce a Public Lighting Consumption Management system* to meet the targets set out in Art. 7 of EED.
- PNEC mentions RPR in its action strategy 4.6. *Carry out the necessary risk assessments, preventive action plans and emergency plans for the energy sector.*
- ELPRE mentions the alignment with the lines established by the EED.
- ELPCPE mentions ED as it establishes the need to define vulnerable costumers and define measures to protect them.

It is also possible to observe on table 45 that ACER and ERD are not mentioned by national instruments. However, since the objective was to analyse the interaction between national instruments and the CEP and not between each legislative act of CEP, it was possible to identify the following interactions:

- There is an interaction within the CEP itself, which can be characterized as an example of a policy mix, its 8 legislations interact directly, it is a form of interaction within the same instrument, inherently complementary and encompasses the 4 dimensions of the interaction.
- CEP has a direct interaction with ELPRE, ELPCPE and PNEC that encompasses the 4 dimensions, presents its form with different instruments - same actors or group and is inherently complementary.
- CEP's interaction with the PRR and local instruments differs from the previous one in its type: it is not direct but operational.
- CEP's interaction with local instruments will only be characterized as indirect and path dependent since, through the individual analysis of local instruments, it is not possible to conclude.

Since the RW is built on measures agreed under the CEP, as was previously described in the single instrument analysis, their interaction will be categorised as direct, 4 Dimensions, different instruments - same actors or group and inherently complementary. Since there is a clear direct interaction between the CEP and RW, the national instruments interaction with the RW will consequently needed to be categorised the same as they were with the CEP. This categorisation it is also strongly supported by the consistent policy strategy found between these instruments.

ECL establish amendment which affect CEP and, consequently, its relationship with the national instruments analysed. Following the previous line of thought adopted to categorise the interaction of the national instruments with the RW, the interaction between the ECL and the national instruments should be the same as their interaction with CEP.

After understanding how European instruments contributed to the development of nationals, it was possible to preview the same type of interaction would be obtained for the PNEC, ELPRE and ELPCPE. The PNEC is the driver which generated the development of the two strategies since they are an integral part of the PNEC. However, it was still needed to observe how the PRR interacted with

national instruments. Through the individual analysis of the documents, it was possible to verify that the PRR established ELPRE and ELPCPE as proposed reforms of the instrument and that PNEC is also mentioned as an integral part of its measures. Therefore, it is concluded that the interaction between national documents should be categorized as direct, 4 dimensions, different instruments - same actors or group, Inherently complementary.

Local instruments were developed as individual initiatives and, therefore, there is no direct relationship recognized by the other instruments and between them. However, their contribution to the fight against energy poverty was concluded by the individual analysis of the instruments and, for this reason, it will be considered that their interaction with other instruments and among themselves is path dependent and indirect. Since its contribution to the policy mix is recognized but not its direct influence on European and national instruments, the shapes and dimensions will not be counted for the categorization of interactions.

In summary, the CEP is the main driver of interaction between the European and National instruments. Four different categories of interaction were identified. These categories are summaries in table 46. The color identifies the different category which is then presented in a matrix which correlate the interaction category between two instruments. For instance, the cell colour between ELPRE and ELPCPE is green, then the category correspondent is the number 2 of the legend. Note that the only instrument which interacts within itself is CEP which, consequently, is the only category whose forms is *within the same instrument*.

Table 46 Interactions between Instruments

		Europe (E)			National (N)				Local (L)		
		CEP	ECL	RW	PRR	PNEC	ELPRE	ELPCPE	GAE	JAC	Habitação A+
W	CEP										
	ECL		-								
	RW			-							
Z	PRR				-						
	PNEC					-					
	ELPRE						-				
	ELPCPE							-			
J	GAE								-		
	JAC									-	
	Habitação A+										-

Legend				
Category	Types	Dimensions	Forms	Combination
1	Direct	4 dimensions	Within the same instrument	Inherently complementary

2	Indirect	Different instruments - same actors or group		
3				
4		-	-	Path Dependent

4.4.3. EVALUATION

Through the individual analysis of the instruments, it was possible to clearly conclude that the Policy Mix in the context of Energy Poverty is a **Complex Multilevel Policy Mix** since it involves multiple objectives, instruments and government levels.

All the instruments analysed involve a mix of objectives that contribute to a climate transition in the context of energy efficiency. The instruments which major focus is the climate transition are PNEC and ECL. However, it should be noted that, even within the climate transition, a multitude of objectives are established that contribute to different areas of this transition.

There is a strong link between the contribution of national and European instruments to the 5 dimensions established by the Energy Union Strategy²³, which demonstrates the coherence of this policy mix in its political strategy (European Commission, 2015).

Furthermore, even though only the ELPCPE defines Energy Poverty concretely, European, national and local instruments interpret the fight against Energy Poverty considering the need for building interventions through, for example, improving energy efficiency, and reducing consumption and energy expenditure. This observation allowed to conclude that there is a strong consistency between the path established by the EU for the definition of the concept, the EPOV indications have been counted and the national instruments use and contribute to this definition in a coherent way. Basically, the three dimensions of energy poverty established by the ELPCPE definition (income, energy and housing) are articulated in a manner consistent with the approach of the other instruments.

When observing the information collected on the single instrument analysis, it was possible to observe how the different instruments developed their measures considering target groups, indicators, measures and different actors. This policy design is prevalently present in CEP, PNEC and ELPCPE. Therefore, consistency was recognised in how the instruments assessed Energy Poverty considering the suggestions of each instrument, specially between the European and national level, and the studies here presented.

²³ Security, solidarity and trust; A fully integrated internal energy market; Energy efficiency; Climate action, decarbonising the economy and Research, innovation and competitiveness.

Based on the consistency of the instruments, it was possible to observe how the interactions of the instruments also followed the measures, indicators and other information collected in the Single Instrument Analysis. Thus, the Policy Mix was evaluated as coherent since the policy strategy developed to fight Energy Poverty contemplates the suggestions of the European instruments, the contextualization of the problem in Portugal and follows the literature recommendations to define Energy Poverty, propose measures focusing on consumers and Energy Efficiency and to use indicators to understand and monitor the issue.

In other words, because of the consistency existent on the target groups, indicators, measures and the different actors which were analysed, the policy strategy to combat Energy Poverty present in the instruments interactions can be evaluated as coherently. Different instruments with different and multiple goals, establish a line to fight Energy Poverty considering the guides of EPOV and, in a bigger scope, the European level requirements and suggestions.

Energy efficiency is the focus of different instruments to define measures to fight Energy Poverty. Considering Portugal context, where energy prices and dwellings conditions take major responsibility to the issue, fighting Energy Poverty with Energy Efficiency measures appears consistent and coherent with the efforts being made by each instrument. Furthermore, energy efficiency is also recognised in the CEP, PNEC and ECL as a step to achieve a sustainable transition and mitigate climate changes. Moreover, in addition to the recognised benefits of energy efficiency to the consumption and income issues, information is also another type of measures targeting the consumers.

In addition to the European and national instruments, the consistency of this policy mix is still ensured by the local instruments since everyone recognizes the three dimensions of the definition established by ELPCPE in its intervention measures in housing and in addressing consumer behaviour to mitigate this problem.

The single instruments and interaction analysis showed that there is a common line developed by the European and national instruments to assess energy poverty through measures focused on dwellings efficiency, decrease of energy consumptions by energy efficiency measures and helping consumers. Moreover, the interaction analysis also showed how synergies of the national and European instruments contributed to define energy poverty measures under the same policy strategy. Therefore, although local instruments are not directly influenced by the other ones, their positive influence on the energy poverty fight policy strategy permits to conclude that this Policy Mix is coherent in its policy strategy and framework to fight energy poverty. It is important to note that the efficiency of measures and their intrinsic coherence was not evaluated in this dissertation.

In summation to this evaluation and based on the importance of the topic of energy poverty in the context of the current political discourse, the survey of the indicators used to measure energy poverty and its categorization was condensed into a network that allows the interaction between the different

instruments and the indicators to be visualized. As previously mentioned, only the PNEC, ELPRE and ELPCPE present their indicators for energy poverty.

It was expectable that European, Local instruments and PRR did not present the indicators. The aim of the European instruments is to guide the national ones to develop their plans and strategy to mitigate Energy Poverty. Although they do not identify the indicators to use, which is normal since the policy discourse and literature defends that Energy Poverty should be contemplated differently in different contexts, they recognise the importance of PNEC, ELPRE and ELPCPE to identify the indicators used.

In conclusion, the Policy Mix analysis permitted to conclude that there is a consistency between the aim of the different instruments which, in addition to the synergies and systemic interactions analysed in the instruments interactions analysis, it is possible to state that the policy strategy and framework is currently being developed coherently to fight energy poverty.

4.4.4. FINAL CONSIDERATIONS

The Single Instrument Analysis aims to collect information from documents in the context of its contribution to the fight against energy poverty. Thus, following the guidelines collected from the literature review and from the EPOV policy guidance, the indicators, target groups, measures and goals of the instruments were analysed whenever they were mentioned in their contribution to energy poverty. Given that the instruments contribute to multiple objectives and different policy spaces, it is important to emphasize that this analysis did not consider the documents' integration, but only the way in which they could contribute to the issue of Energy Poverty. In addition, the actors corresponding to the measures in the scope of energy poverty of each instrument were also collected whenever it specified them.

In this regard, three instruments were identified having a strong component in the context of Energy Poverty. As to be expected, the **ELPCPE** is the most complete of these instruments and, although, for example, it contributes to climate transition and building renovation, the focus of the proposed measures is the alleviation of Energy Poverty. The measures are distributed in 4 different areas (Energy Efficiency, Price Support and Charges Reduction, Consumer Protection and Information, Knowledge and Education) and are accompanied by the definition responsible and funding actors and their contribution to different indicators. Therefore, it is understood that this instrument follows the guidelines outlined by EPOV and by the European instruments, showing its importance for the Energy Poverty Policy Mix in Portugal studied here.

ELPRE, in turn, naturally focuses on the renovation of buildings and contributes to improving housing conditions and energy efficiency, which is, as previously seen, one of the important factors to alleviate Energy Poverty, especially in Portugal. Therefore, this instrument proposes specific measures to combat Energy Poverty through interventions in buildings and, in the single instrument analysis, the indicators and target groups that it identifies were collected and organized. Unlike the ELPCPE, this

instrument does not specify the actors for the corresponding measures. Therefore, the actors of the ELPRE assessing Energy Poverty were not collected since it would require analysing all the measures individually, including those not related to energy poverty, and assume their respective actor which is not the scope of this dissertation.

PNEC is a plan that arises in consequence of **GEUR** where the guidelines and objectives to be achieved in this plan are established. In **PNEC**, the creation of the ELPRE is also defined, as an integral component of the instrument and in its contribution to the climate transition. It also mentions the **ELPCPE** as an instrument to be implemented, under the energy and climate topic, to contribute especially to the C8 component of the **PNEC**. In addition, this instrument also specifies the measures that must be implemented to alleviate Energy Poverty, as required by the **GEUR**, and 3 national goals (C1 Decarbonize the National Economy, C3 Reinforce the focus on renewable energies and reduce the country's energy dependence and C8 Ensure a fair, democratic and cohesive transition) are identified in their contributions to Energy Poverty fight. These measures are also accompanied by the definition of responsible and funding actors. Finally, in the public consultation version, **PNEC** establishes different indicators to be used for monitoring measures to combat energy poverty in its C8 component.

At national level, the analysis was also made to the **PRR**, which proposes ELPRE and **ELPCPE** as reforms. In addition, the C13 component, which is the only component directly mentioning and establishing Energy Poverty as one of the multiple goals, foresees 300 M € for energy efficiency in residential buildings. This fund is destined to both strategies. It is also mentioned the allocation of 100,000 vouchers to support efficient energy solutions to families in a situation of energy poverty, which, in turn, corresponds to measure 1.2 of the Energy Efficiency area of action of the **ELPCPE**. However, this plan does not specify the indicators used or to use for Energy Poverty measurement.

The European instruments are the main drivers for defining national instruments. In particular, the **CEP** encompasses 8 legislations (**EPBD**, **RED**, **EED**, **GEUR**, **ERD**, **ED**, **RPR** and **ACER**) that establish the lines of action, targets, implementation periods and suggest measures that can be adopted or other sources of information to appeal in the selection of measures and indicators. In addition, the **RW** and **ECL** have an important interaction with the **CEP** in their contribution to the energy transition and, consequently, to the climate transition, since both change directives that belong to the **CEP** (**EED**, **EPBD** and **GEUR**) and follow a strategic policy of implementing measures at different levels to achieve the Paris Agreement targets and the objectives defined at European level.

At the local level, 3 different initiatives - **JAC**, **GAE** and **Habitação A+** - are developed independently and recognize the different factors that contribute to Energy Poverty. Thus, all recognize the role of improving the energy efficiency of homes through interventions in buildings or information to consumers to alleviate energy poverty. Except for the **GAE**, which was developed through a European project to fight energy poverty (**STEP**), Energy Poverty appears as a complementary objective of the initiatives on its way to improve housing conditions in general.

Therefore, after the Single Instrument analysis, it was possible to verify that there is a common political strategy between the analysed instruments. This policy strategy includes:

- Recognition of the problem of energy poverty.
- The path to the definition of energy poverty by the ELPCPE at national level.
- Agreement on the three essential factors of Energy Poverty -income, buildings/energy efficiency and energy prices.
- The alleviation of Energy Poverty through measures that follow the above factors.
- Recognition of the importance to establish indicators for Energy Poverty.
- The recognition of the complexity and multitude of Energy Poverty that requires the combination of various instruments and different elements for its mitigation.
- The relationship between the different political dimensions to establish measures to combat Energy Poverty.
- The agreement between the implementation period between the different instruments (varying until 2030 or 2050).

Following this recognition of consistency within the instruments and coherence within the political strategy to which they contribute, the figure 42 summarizes the highlighted interactions that contributed to the categorization of 4 different interactions. The interaction categories are sorted by the Types, Dimensions, Combinations and Forms:

- **Category 1**, within CEP: Direct, 4 Dimensions, Within the same instrument and Inherently complementary.
- **Category 2**, within the national instruments and between the European instruments and PNEC, ELPRE and ELPCPE: Direct, 4 Dimensions, Different instruments - same actors or group and Inherently complementary.
- **Category 3**, between PRR and the European instruments: Indirect, 4 Dimensions, Different instruments - same actors or group and Inherently complementary.
- **Category 4**, within the local instruments and the other instruments: Indirect and Path dependent.

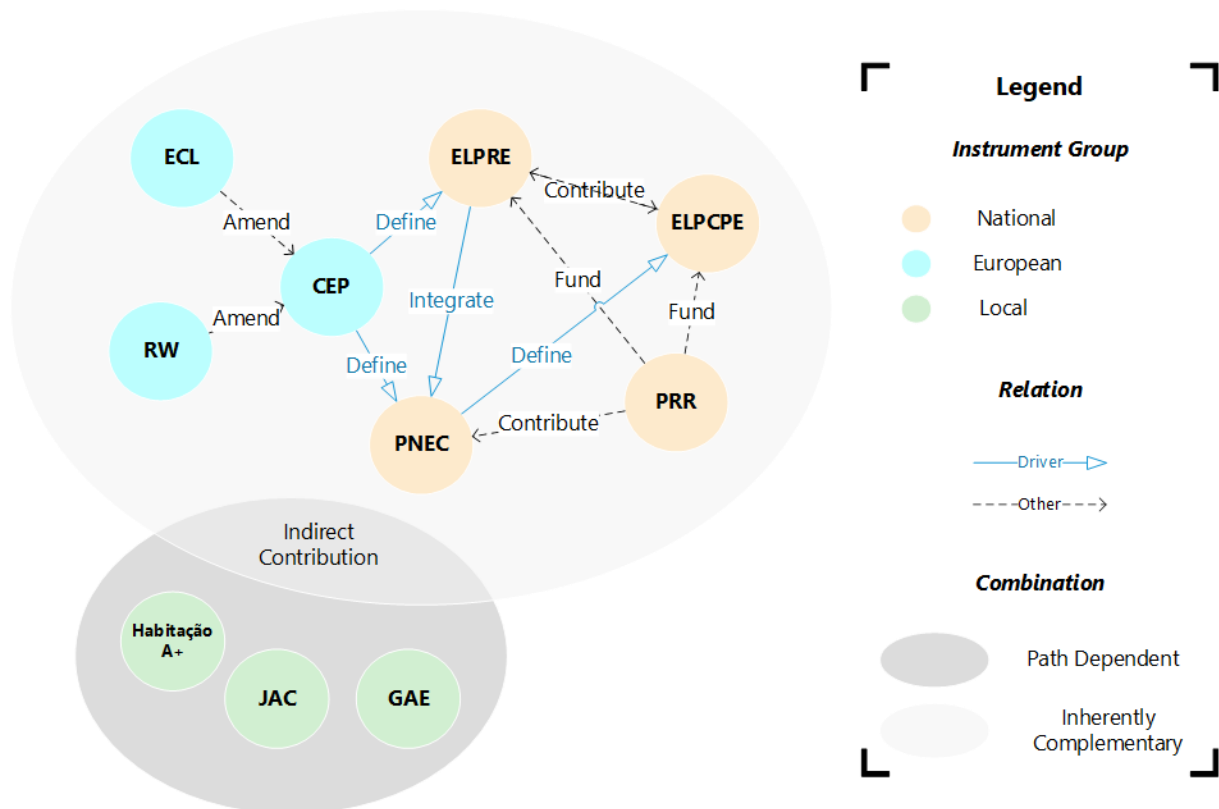


Figure 42 Highlighted Interactions between the instruments.

In summary, through the framework for Policy Mix analysis here proposed, the instruments selected were firstly subjected to an individual analysis which aimed to understand how these instruments contributed to the Energy Poverty Policy Mix in Portugal. Then, based on this information, it was possible to note a concordance between the policy strategy being adopted to fight energy poverty and, consequently, the interactions within instruments were analysed in detail which consequently identified 4 different categories of interaction. Lastly, the evaluation of the policy mix was detailed under the consistency and coherence criteria, which recognised that the Multi-Level and Complex Policy Mix here studied is coherent in its adopted policy strategy to fight energy poverty.

5

DISCUSSION, CONCLUSIONS AND FURTHER RESEARCH

5.1. DISCUSSION AND CONCLUSIONS

Different OECD publications recognised the connections between Policy Coherence, Policy Mix and sustainable transitions (Moure et al., 2021; OECD, 2007, 2019). Considering this, three major concepts were addressed and related to further analysis of the Portuguese case study on Energy Poverty.

The theoretical background evidenced that Policy Mix does not currently have an accepted definition nor a method to its analysis. However, it was possible to recognise a pattern of the current literature on the topic, which consider especially three blocks: Elements, Policy Process and Characteristics (Edmondson et al., 2019; Rogge et al., 2017; Rogge & Reichardt, 2016). Furthermore, these blocks are also considered for Policy Mix analysis as was the case of the Mavrot et al. (2018) study.

Policy Coherence, on the other hand, was directly related to other concepts, such as Integration and Coordination, and it was recognised that, even though not directly mentioned, Policy Mix blocks were generally used to address and evaluate the mix of instruments and the policy in general by the authors (Chan et al., 2021; Moure et al., 2021; OECD, 2018b).

Energy Poverty appears as a complex issue requiring the blocks of Policy Mix to define a battle for its mitigation. Therefore, it is understandable how Energy Poverty is a recent topic under the European and National level and there is vast studies offering guidance and essential information to design policies to tackle it (Gouveia et al., 2019; Kyprianou et al., 2019; Primc & Slabe-Erker, 2020; Thomson & Bouzarovski, 2019). For this reason, a framework for Policy Mix analysis is proposed and its application is tested on the Portuguese case study.

The framework for Policy Mix analysis was backed by the state-of-the-art literature on the subject. Different methodologies for policy analysis in different fields, topics and goals helped deconstruct the framework patterns and the Policy Mix concept itself. Thus, the framework proposed contemplates 5 major steps – Define Objectives, Instrument Selection, Single Instrument Analysis, Instruments Interaction Analysis and Evaluation - and an iterative process which reinforces the importance of contextualization and the pathway, Ex Ante or Ex Post, of the Policy Mix addressed. In other words,

the framework proposed cannot only be adopted for the Energy Poverty, but is opened to be used for other topics, to evaluate the Policy Mix with the adequate, and proposed, criteria.

Without a doubt, testing the framework on the case study is the essential step to show its relevance. In total, 10 instruments were selected and analysed, being one of the instruments composed by 8 legislative acts itself. The aim of the analysis was to cover how the policy strategy to fight Energy Poverty is currently being addressed in Portugal.

Based on the combination of the two steps covering the instruments analysis, it was possible to observe how the instruments contributed to the Energy Poverty topic and how they interact with each other. For instance, it was showed how the CEP is the major driver of the national instruments and that ELPCPE follows the indications of the European instruments and the literature on Energy Poverty itself. However, it is important to reinforce that the aim of this dissertation is not to analyse how efficient or effective the measures are, but how the Policy Mix, on the overall, follows a clear and coherent strategy for Energy Poverty mitigation.

The Instruments Interactions analysis is the focus and most relevant contribution of the framework. In total, four different elements were considered to categorise the interactions between the instruments one-on-one. This was essential to understand the taxonomy of the Policy Mix, the inconsistency of some instruments and to visualize how a policy strategy is being developed, integrating three different levels (European, national and local) and following a common timeline. Four different categories were identified showing a direct relation of the European and national level, on the overall, and the local instruments contributed indirectly to this mix. The categories identified, orderly covering the Types, Dimensions, Forms and Combinations, were:

- **Category 1**, within CEP: Direct, 4 Dimensions, Within the same instrument, Inherently complementary.
- **Category 2**, between PNEC, ELPRE, ELPCPE and European instruments: Direct, 4 Dimensions, Different instruments - same actors or group, Inherently complementary.
- **Category 3**, between PRR and the European instruments: Indirect, 4 Dimensions, Different instruments - same actors or group, Inherently complementary.
- **Category 4**, between and within the local instruments with other instruments: Indirect and Path dependent.

The Evaluation was an important step to define the final considerations of the Policy Mix addressed. Two major criteria were selected to evaluate the case study: consistency and coherence.

The policy strategy to fight Energy Poverty in Portugal was concluded coherent. This was sustained on how the base of definition, goals and measures around Energy Poverty contemplate its different factors: income, energy prices and energy efficiency. The consumers are especially considered in all instruments which define measures, contributes to Energy Poverty mitigation, or guide how Energy Poverty should be addressed.

The consistency criteria, on the other hand, was able to recognise how ELPRE fails to define the actors to the Energy Poverty topic and that PRR does not explain on how 100 000 vouchers will be addressed, while ELPCPE integrates this measure and specifies its indicators and actors.

In summary, the major contributions of the proposed framework and adopted in the Portuguese Case Study on Energy Poverty were:

- Disentangle a robust and extensive combination of instruments, condensing the relevant information on Energy Poverty of instruments that encompass different goals, fields and measures.
- Identify the targets, indicators, measures, and actors of each instrument under the Energy Poverty topic.
- A flexible and yet systemic analysis process allowed to visualize the interactions and find the instruments contributing more for the Policy Mix.
- Define the taxonomy of the Policy Mix.
- Categorise the instruments interactions based on a homogenous method which allows to directly compare and visualize the different interactions.
- Evaluate the Policy Mix under two major criteria, Coherence and Consistency, while considering their comprehensiveness too.
- Communicate the Policy Mix on Energy Poverty clearly, and construct a dataset supporting the topic which can be used to understand the instruments individually and, more importantly, their interactions.

As can be expected from a Complex Multilevel Policy Mix, an extensive and exhaustive work was required by the 10 instruments selected. Although there is a coherent policy strategy to tackle Energy Poverty currently being developed/implemented, official and recent information about the selected instruments, was harder to find on a national and local level.

ELPRE stood out of the instruments analysed because it was the instruments where more difficulties were encountered. First, understanding the actors of Energy Poverty measures is not straightforward. Second, the design of the document limited the information that could be collected. Lastly, the official version of the document was not easy to find.

It should be noted that this dissertation aimed to develop a new framework to analyse Policy Mix and, for this reason, the focus of the case study was not to understand every type of possible combinations. Therefore, the instruments were only analysed with the aim of understanding the measures, indicators, actors, target groups and goals of 1 to 1 combination of instruments were being developed to combat Energy Poverty. In this way, other types of combinations and topics were not cover in this analysis which, as will be further mentioned, can be an opportunity to further research.

In conclusion, the proposed framework for Policy Mix analysis was able to give the tools for assessing the Portuguese Policy Mix on Energy Poverty successfully. This framework evolves an iterative process, and its flexible and systemic structure helps to disentangle the exhaustive works to overview the contributions of the single instruments to a defined topic and to visualize the interactions between. Therefore, different pathways can be chosen, and various policy fields can be addressed by the proposed framework. Lastly, the case study not only contributed to test the framework and to understand the Policy Mix at a practical level, but Energy Poverty was also addressed on its different elements, drivers, factors and contexts.

5.2. FURTHER RESEARCH

Through the development of the Framework for Policy Mix Analysis and the Portuguese case study on Energy Poverty, it was possible to highlight different points to further research such as the capability of the framework to be used in other topics.

Firstly, based on the analysis of the Cases Study on Energy Poverty, it is interesting to evaluate the measures intrinsically. There are already different studies covering the effects of different types of measures and interviews could be used to address the actors and targets opinions on the credibility of this measures. In consequence, not only the Energy Poverty but also the Policy Mix could benefit from this study.

Secondly, considering that ECL and ELPCPE are not already being implemented, it is possible to follow this work and contribute to the management and monitorisation of the Efficiency and Effectiveness of the Policy Mix. Because of the early stage that the instruments selected are, covering the different phases of Policy Mix evolution can also add to further understanding, not only the Energy Poverty issue but also, how Policy Mix can contribute to emergent complex and rapidly changing issues.

Thirdly, based on the relation of Energy Poverty, Energy Efficiency and the EU development of strategies for Energy transitions and buildings renovation stated in this work, the framework proposed could be applied to the Energy Efficiency and Renovation Wave to understand how different instruments are being integrated in a Policy Mix to assess these topics. This study can be done not only in Portugal but also in another European Union Member State since the CEP and RW were already addressed and analysed in the case study.

Lastly, a common repository could be developed to help different entities, and the general population, to read and follow the development of the national policies and local initiatives. This common source could be inspired on the existent sources considered for this dissertation, such as the website of the European Union, the EPOV or ENGAGER (Engager, 2019; EPOV, 2021a; European Union, 2019a). In addition, this common source could also be integrated on the transparent efforts currently being addressed by EU and Portugal (European Commission, 2021; República Portuguesa, 2021c).

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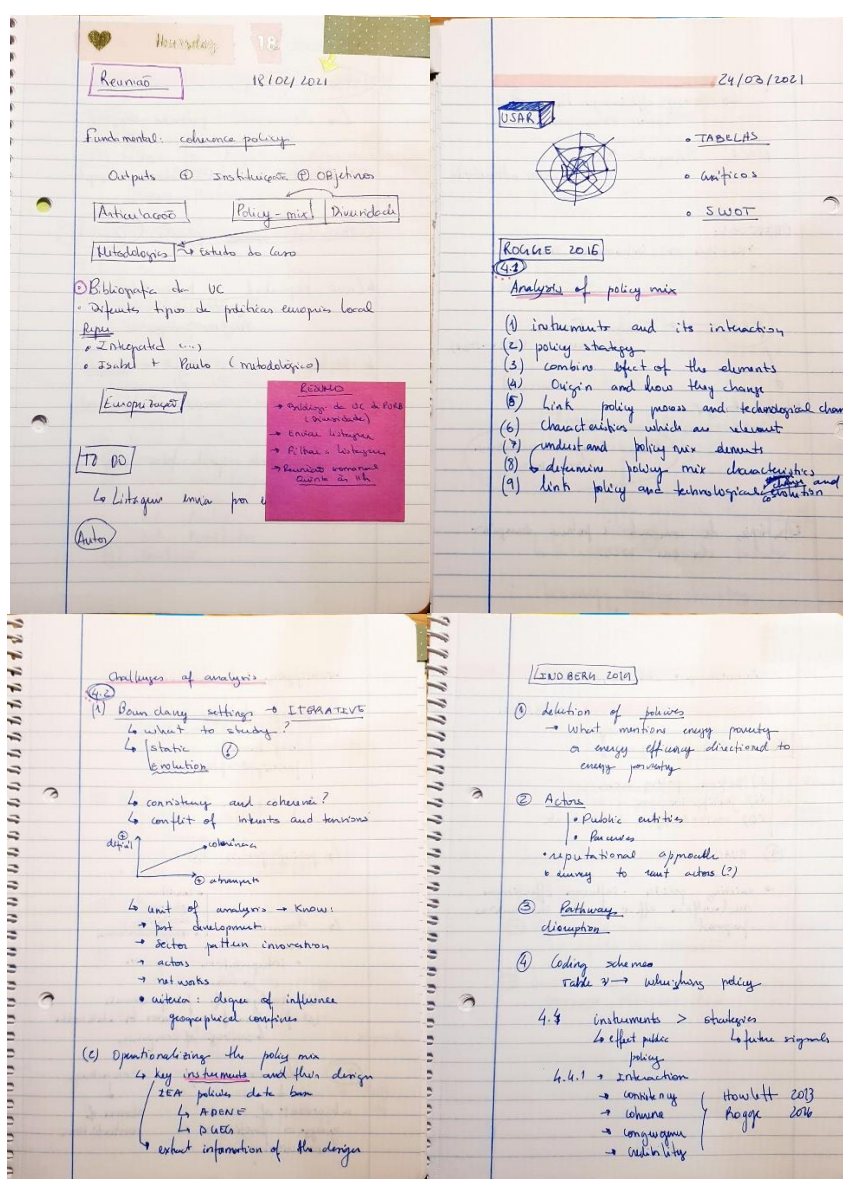
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ANNEX

A1. LITERATURE ANALYSIS: COMPLEMENTARY INFORMATION

The Brainstorm and Free search step of literature selection was accomplished with the documentation of all the process. All the information was organised with the help of Excel tables (Annex Table 1) and a diary notebook (Annex Figure 1) which was used during the entire process of the dissertation, to draft in a more natural and freer tactic the patterns found. Moreover, the notes taken in this step were essential to help define how the systemic analysis should proceed and the highlighted literature in this step helped define the keywords combination.



Annex Figure 1 Example of notes taken on the diary during the whole framework (Source: own)

Search Tools	Keywords	Political Agreements/Projects		EU Energy		Portugal Political	
		Acronym	Name	Acronym	Name	Acronym	Name
Google Scholar	Articulation						
IEEE	Climate Change	Pa	Paris Climate Agreement	(EED)	Energy Efficiency Directive	IFFRU 2021	Instrumento Financeiro Para A Reabilitação E Revitalização Urbanas
Journal Finder Elsevier	Climate Policy	Pcd	Political Coherence for Development (Ocde, 1990's)	RW	Renovation Wave	ELPRE	Estratégia De Longo Prazo Para A Renovação Dos Edifícios
Mendeley	Coherence Policies	Sdg's	Agenda For Sustainable Development	-	Mitigating Household Energy Poverty	-	Programa De Apoio - Edifícios Mais Sustentáveis
Microsoft Academic	Cohesion	Nua	New Urban Agenda (Onu)	Policy Recommendations		PEES	Programa De Estabilização Económica E Social
Publish Or Perish	Coordination	Sfdrr	Sendai Framework For Disaster Risk Reduction	STEP	Solutions To Tackle Energy Poverty	PRR	Plano De Recuperação E Resiliência
Rsa	Cross-Impact Analysis	Gidrm	Global Initiative On Disaster Risk Management (Alemanha)	POCITYF	Positive Energy Buildings & Districts	PAES	Programa De Apoio Edifícios Mais Sustentáveis
Science	Energy Poverty	2030	The 2030 Agenda	EPO	Energy Poverty	FA	Fundo

Direct			Agenda	For Sustainable Development (Onu)		Observatory		Ambiental
Scopus	Environmental Policy Integration		Energy 2020	Energy Strategy (Ue Commission) Planning And Research Of Policies For Land Use And Transport For Increasing Urban Sustainability	.	Conventions Of Mayors	TSE	Tarifa Social De Energia
VOSviewer	Europe		Propolis	Brundtland Report (1987, Onu)	.	Assist Together	PT2030	Portugal 2030
	Incongruity		Brundtland Report	Agenda 21 (1992, Onu)		Report On The State Of The Energy Union	CE2020	Casa Eficiente 2020
	Inovation Policy		Agenda 21	Charter Of Aalborg— European Cities And Towns For Sustainability (1994, Ue)	ECL	European Climate Law	(RNC2050)	Roteiro Para A Neutralidade Carbónica 2050
	Integrated Policies		Charter Of Aalborg		NECP	Assessment Of The Final National Energy And Climate Plan Of Portuga	PNEC 2030	Plano Nacional Energia E Clima 2021-2030
	Interdependencies		Acquis Urban		.	Recommenations On Energy Poverty	AV PNEC	Avaliação Do Plano Nacional Final Em Matéria De Energia E Clima De Portugal
	Paradoxes		.	Leipzig Charter On Sustainable	RW	Stakeholder Consultation On The	PAES	Programa De Apoio Edifícios

			European Cities (European Union 2007)	Renovation Wave Initiative		Mais Sustentáveis
	Policy Analysis	:	Declaration Of Toledo (European 2010)	A7 Article 7: Energy Efficiency Obligation Schemes		
	Policy-Mix	:	Cities Of Tomorrow	ENEU Energy Union		
	Proactive Role	:	Riga Declaration Energy			
	Regional Policies	Ecbd	Performance Of Buildings Directive	(CEP) Clean Energy For All Package ,		
	Sinergies	(Eed)	Energy Efficiency Directive			
	Smart Specialisation					
	Sustainable					

Annex Table 1 Brainstorm and Freesearch information collected

The criteria used to select the information of the literature in a productive management of time considered the title, keywords, abstract and conclusions of each paper. In this step, the search could also lead to a more integral reading of the paper if it was instinctively interesting to do so. At this time, it was already considered the period, number of citations of the papers and the use of different search engines such as Microsoft Academic, Google Scholar, Scopus and Science Direct.

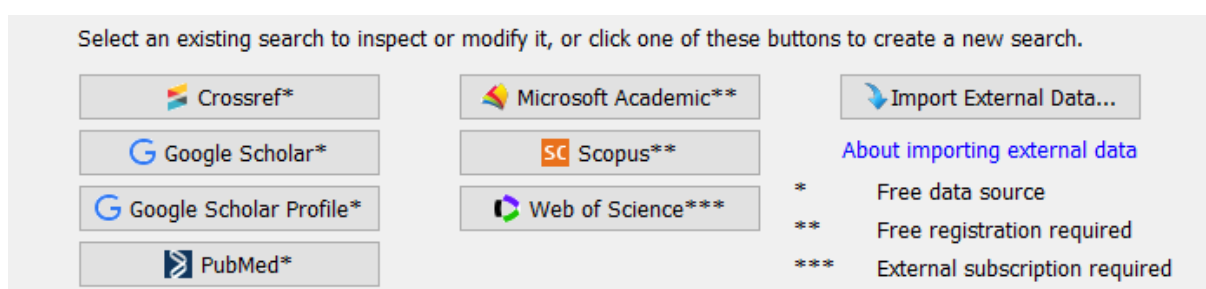
Meanwhile, it was also considered different type of search engines which could direct to other forms of information to complete. For instance, different topics videos, such as, on how to search more effectively, official videos by OECD, UE and governmental entities were visualized. Different daily journals and cultural instruments which could positively contribute to the search of literature were also considered.

The goal with this method was to brainstorm with the help of different existent information to achieve a less unbiased search without being limited by only one type of searching methods. This step was a combination of the creating a 'skeleton' to further search and analysis of literature and a more natural approach of learning the existent tools to use to achieve that. However, it is important to note that this was only possible because of the freedom given by the theme and the orientation of the professors which with their background on different urban policies topics could help funnel the attention to a more precise selection of the theme and tools used.

After approximately two weeks, it was understood that Policy Mix, Coherence and Climate were the three keyword to use on the following step. It was also found that, with a bibliometric approach on literature analysis, the combination of **VOS Viewer** and **Harzing's Publish or Perish** software it was possible to have a more productive and systematic approach on literature to define the limits of the theme and to start analysing more fully the selected papers. After the comparison of different bibliographic manager software, Mendeley was chosen as the software to take notes and analyse the papers. The reason of this choice was especially because of the synchronization and the existent extension aptitudes that would make it simpler to select and analyse literature.

After a period of free analysis of the information, it was the time to implement a **Systematic Search of literature**. Software was an important tool used in this step to manage time, quantity and quality of literature which could be used to this dissertation.

Harzing's Publish and Perish (HPP) is a software program which integrates different search engines in a way to find more literature more rapidly though an analyzation of academic citations and different metrics (Harzing 2020). Annex Figure 2 illustrates the different data sources integrated in the software being Google Scholar, Microsoft Academic and Scopus the more used ones because of their speed and number of papers normally achieved.



Annex Figure 2 Search Engines integrated in Harzing's Publish or Perish

One of the advantages of HPP to the selection of literature was the fact that all search history could automatically be saved and exported to different software. This was a very useful feature since it made possible to visualize the authors and their keyword with the help of VOSviewer, backup the literature on different keywords and the access to previous searches in case of need to rethink and remember what was already done. Another advantage is the easy appliance of different criteria to search. Annex Figure 3 shows two examples of how different data sources have different possible ways to search for the same topic. However, to a more systematic and easier comparative method, the order of more used options was keywords, years, title and authors. Search direct was another feature used to more rapidly find the better classified literature retrieved by HPP.

Microsoft Academic search [How to search with Microsoft Academic](#)

Authors: Years: 0 - 0

Affiliations: Study field:

Full journal name: ISSN:

Title words:

Keywords: portugal urban policy coherence

Google Scholar search [How to search with Google Scholar](#)

Authors: Years: 2017 - 2021

Publication name: ISSN:

Title:

Keywords: Policy coherence

Maximum number of results: 1000 (may be further limited by data source)

Annex Figure 3 Harzing's Publish or Perish example of searching features for Microsoft Academic and Google Scholar

Furthermore, on Annex Figure 4 it can be observed the full panel example of Integrated Urban Policies search of literature on HPP. HPP lets the user organise the literature in different order by column, adapt the size of the columns to better compare the information, select the literature to save and export to other software and access to the metrics of the results for a fast analysis of the literature. This was an important help to have an overview of the papers and to more rapidly select the literature to read more extensively. VOSviewer was the next step to further find the pattern and connection of the literature.

A Framework for Policy Mix Analysis: Portuguese Case Study on Energy Poverty

Harzing's Publish or Perish (Windows GUI Edition) 7.30.3245.7741

File Edit Search View Help

My searches

Search terms

Search terms	Source	Papers	Cites	Cites/ye...	h	g	hI,norm	hI,annual	hA	acc10	Search date	Cache date	Last...
policy analysis sustainable development from 2015 to 2021	Scopus	200	30824	5137.33	104	168	103	17.17	45	200	18/02/2021	18/02/2021	0
policy analysis sustainable development from 2015 to 2021	Scopus	200	30824	5137.33	104	168	103	17.17	45	200	18/02/2021	18/02/2021	0
urban policy coherence mix	Google Sch...	249	61851	1438.40	108	248	87	2.02	37	128	23/02/2021	23/02/2021	89
integrated urban policies	Microsoft Ac...	1000	43802	952.22	104	178	71	1.54	24	118	23/02/2021	23/02/2021	0
policy integration sustainable from 2015 to 2021	Microsoft Ac...	1000	14079	2346.50	59	93	29	4.83	25	94	18/02/2021	18/02/2021	0
portugal urban policy coherence	Google Sch...	370	20365	75.15	66	135	52	0.19	23	69	23/02/2021	23/02/2021	89
Energy Policy, Portugal urban from 2014 to 2021	Google Sch...	140	7692	1008.86	51	79	30	4.29	20	67	10/03/2021	10/03/2021	89

Microsoft Academic search

How to search with Microsoft Academic

Authors: Years: -

Affiliations: Study field:

Full journal name: ISSN:

Title words:

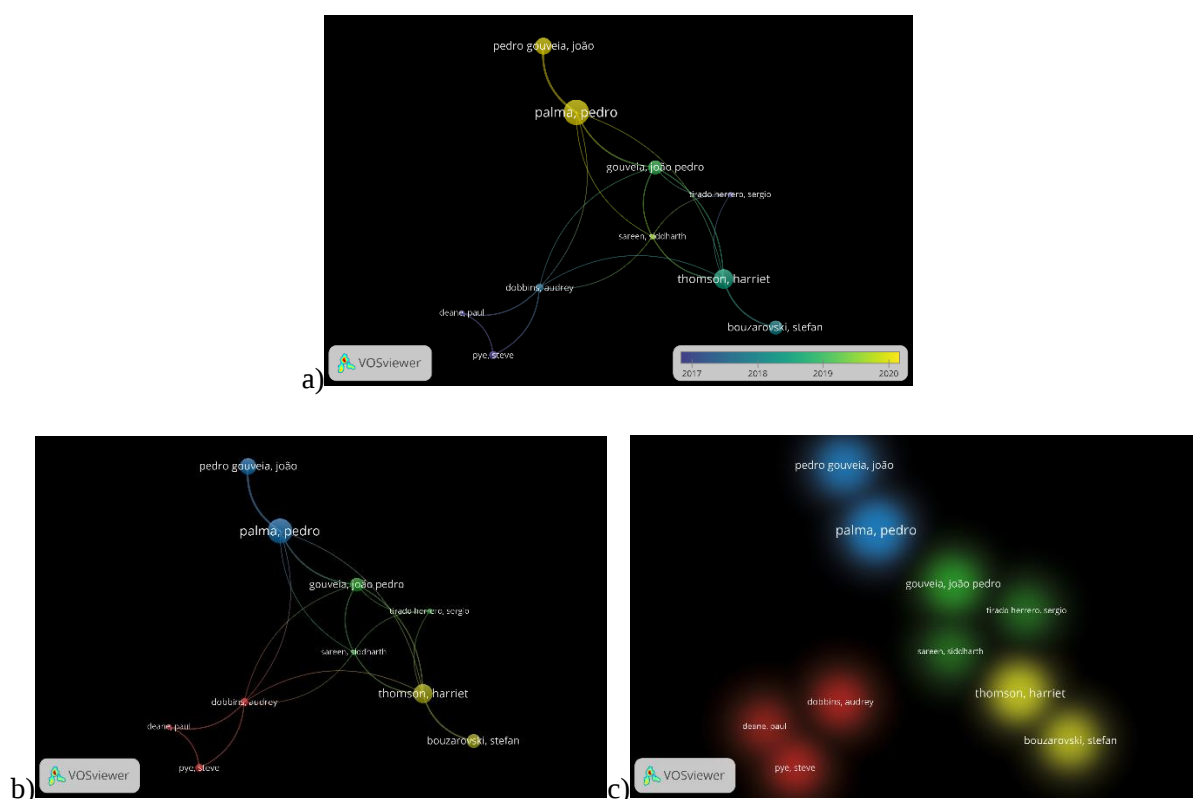
Keywords:

Results

Results	Cites	Per year	Ra...	Authors	Title	Year	Publicat...
Publication years: 1975-2020	h 7...	735.00	4	Donald A. Hammer	Constructed wetlands for wastewater treatment: municipal, industrial, and agricultural	2020	1st Intern...
Citation years: 46 (1975-2021)	13	13.00	499	Luis A. Guzman, Francisco Escob...	A cellular automata-based land-use model as an integrated spatial decision support system for urban planning in developing cities: The case of the Bogotá region	2020	Land Use
Papers: 1000	11	11.00	544	Billie Giles-Corti, Melanie Lowe, ...	Achieving the SDGs: Evaluating indicators to be used to benchmark and monitor progress towards creating healthy and sustainable cities	2020	Health Po
Citations: 43802	8	8.00	649	Anna Magrini, Giorgia Lentini, S...	From nearly zero energy buildings (NZEB) to positive energy buildings (PEB): The next challenge - The most recent European trends with some notes on the energy analy...	2020	Developm
Cites/year: 952.22	7	7.00	696	Hong-Mei Deng, Can Wang, We...	Managing the water-energy-food nexus in China by adjusting critical final demands and supply chains: An input-output analysis.	2020	Science o
Cites/paper: 43.80	7	7.00	704	Mona Hemmati, Bruce R. Elling...	The Role of Urban Growth in Resilience of Communities Under Flood Risk	2020	Earth's Fu
Authors/paper: 3.21	6	6.00	742	Berhanu Keno Terfa, Nengcheng...	Urbanization in Small Cities and Their Significant Implications on Landscape Structures: The Case in Ethiopia	2020	Sustainab
h-index: 104	6	6.00	752	Xiao Sun, Huajun Tang, Peng Yan...	Spatiotemporal patterns and drivers of ecosystem service supply and demand across the conterminous United States: A multiscale analysis.	2020	Science o
g-index: 178	6	6.00	757	Wanxu Chen, Guangqing Chi, Jia...	The spatial aspect of ecosystem services balance and its determinants	2020	Land Use
hI,norm: 71	6	6.00	769	Lochner Marais, Stuart Paul Den...	Mining towns and urban sprawl in South Africa	2020	Land Use
hI,annual: 1.54	5	5.00	818	Ayyoob Sharifi	Trade-offs and conflicts between urban climate change mitigation and adaptation measures: A literature review	2020	Journal of
hA-index: 24	5	5.00	821	Martin Otto Paul Ramacher, Mat...	Integrating Modes of Transport in a Dynamic Modelling Approach to Evaluate Population Exposure to Ambient NO2 and PM2.5 Pollution in Urban Areas	2020	Internatio
Papers with ACC >= 1,2,5,10,20: 697,521,277,118,36	5	5.00	844	Jairo Ortega, János Tóth, Tamás ...	An Integrated Model of Park-And-Ride Facilities for Sustainable Urban Mobility	2020	Sustainab
Copy Results	4	4.00	890	Kathleen Newland	Lost in transition.	2020	Science
Save Results	4	4.00	896	Boglárka Méreiné Berki, György ...	THE ROLE OF SOCIAL CAPITAL AND INTERPERSONAL RELATIONS IN THE ALLEVIATION OF EXTREME POVERTY AND SPATIAL SEGREGATION OF ROMANI PEOPLE IN SZEG...	2020	Jura - Juri
Frequently Asked Questions	4	4.00	913	Elzbieta Zysk, Agnieszka Dawid...	The concept of a geographic information system for the identification of degraded urban areas as a part of the land administration system - A Polish case study	2020	Cities
Training Resources (multilingual)	4	4.00	944	Lanping Tang, Xinli Ke, Ting Zho...	Impacts of cropland expansion on carbon storage : A case study in Hubei, China	2020	Journal of
YouTube Channel	4	4.00	952	Nawhath Thanvisitthpon, Sanga...	Assessment of flood adaptive capacity of urban areas in Thailand	2020	Environm
	3	3.00	996	Yurui Li, Yi Li, Dávid Karácsonyi, ...	Spatio-temporal pattern and driving forces of construction land change in a poverty-stricken county of China and implications for poverty-alleviation-oriented land use ...	2020	Land Use
	3	3.00	998	Felipe F. Dias, Patricia S. Lavieri, ...	A comparison of online and in-person activity engagement: The case of shopping and eating meals	2020	Transport
	79	39.50	127	Jiuhui Qu, Hongchen Wang, Kaij...	Municipal wastewater treatment in China: Development history and future perspectives	2019	Frontiers
	34	17.00	195	Patricia S. Lavieri, Patricia S. Lavi...	Investigating objective and subjective factors influencing the adoption, frequency, and characteristics of ride-hailing trips	2019	Transport
	22	15.00	215	Erika Sarotta, Erika Sarotta, Paul...	A review study about energy consumption of building facades with BIM in urban environment	2019	Sustainab

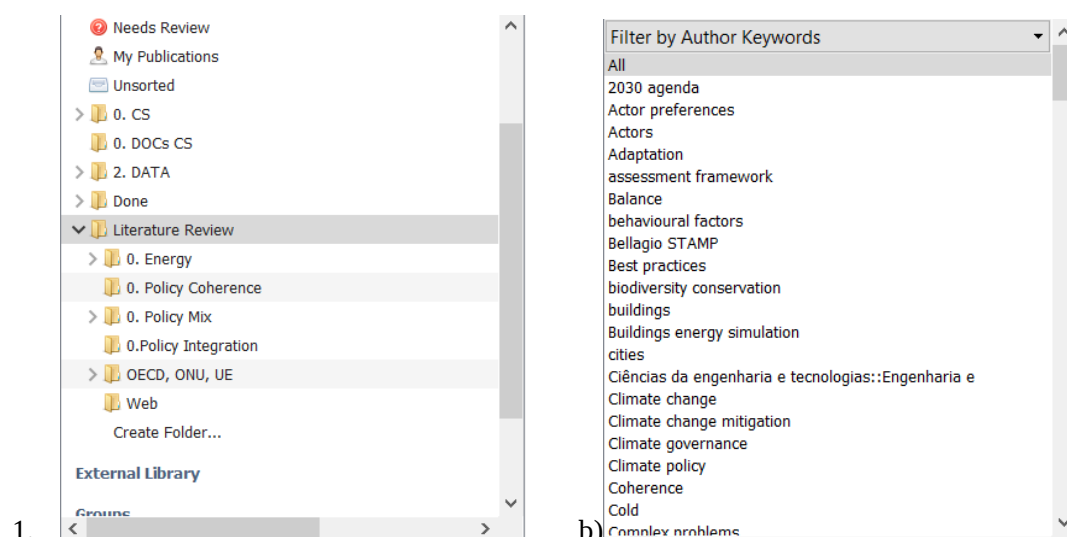
Annex Figure 4 Harzing's Publish or Perish example of search

“VOSviewer is a software tool for constructing and visualizing bibliometric networks” (VOSviewer, 2020). This software was selected to visualize the connections of the literature, the most cited authors and their relation, the patterns of the time and citation and to find the different keywords and their relation. Annex Figure 5 shows the three types of visualization that can be used: network, overlay and density. In this scenario, the case study has already been defined and it is possible to observe how easily it can be understood through the images the most relevant authors on the topics. The most important images to decide which keywords or authors would be used to this work were saved in a timeline code to further visualize the funnel search process of the work and to have the backstory in case it was needed to better find some information in a specific topic (Annex 2).



Annex Figure 5 VOSviewer different types of visualization: a) Overlay, b) Network and c) Density.

After the iterative process of HPP and VOSviewer selection of literature, the highlighted literature was exported from HPP to Excel to read the abstract of the papers. With this step it was possible to understand if the topic of the article and decide if it was necessary to further read the article or to go back to select literature again. In case of the former situation, the article was read with the help of Mendeley software which is an reference manager software where the user can organise the literature in different folders (figure), take notes and highlight the text and share it with other users (Mendeley, 2021). This software was chosen specially because of its user-friendly interface which makes it easier to access in any device, automatically backup online and its synchronization feature which makes possible to work anywhere with any device. The extension in chrome was a frequently used since it easily saves the pdf on the software in the desktop without having to download it and being afraid to lose it. Another interesting and frequently used feature it is the filter options (figure) and selection of organisation by author, publication or added date order because it helps to navigate through the filtered literature after its selection and during the writing process.



Annex Figure 6 Mendeley Folder organisation (a) and Filter by Author Keywords (b) features (Source: Own)

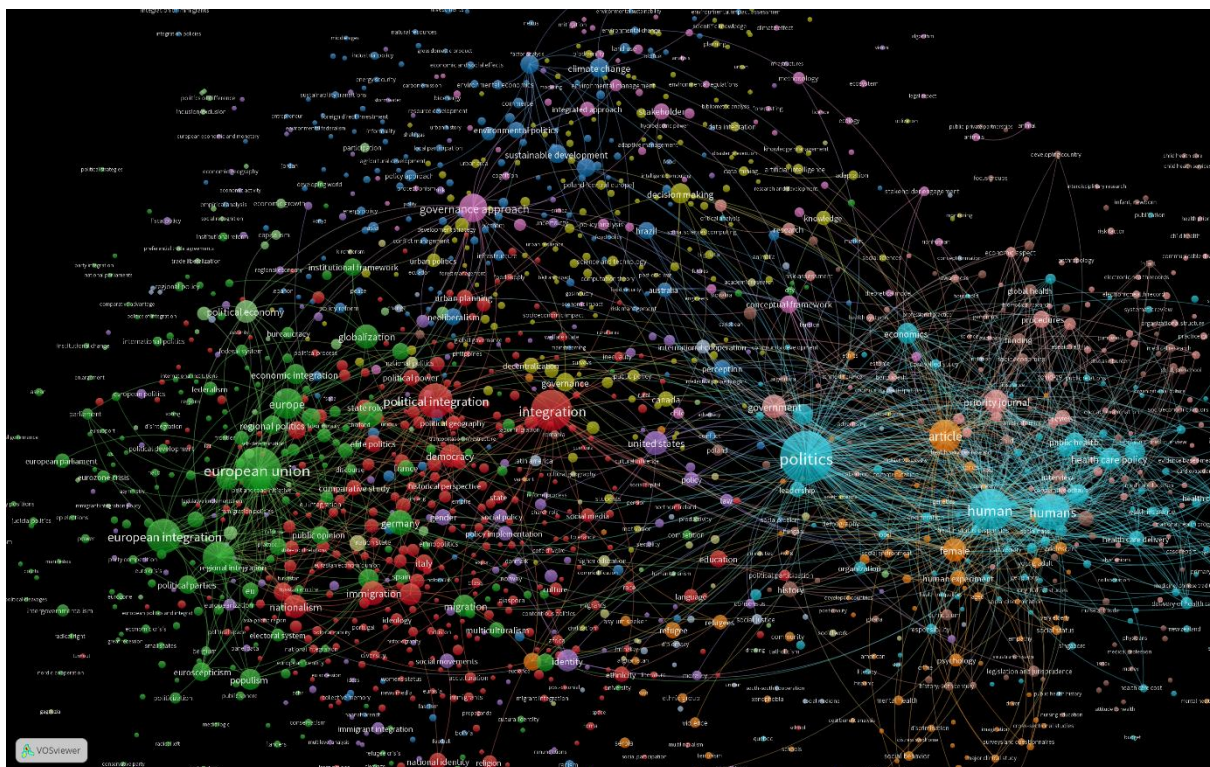
Cites	Authors	Title	Year	Source	Abstract
0	Gijs Diercks	Lost in translation: How legacy limits the OECD in promoting new policy mixes for sustainability transitions	2019	Research Policy	<i>"The OECD has a strong legacy in shaping innovation policy mixes. The purpose of this paper is therefore to provide a better understanding of how the OECD is currently shaping new policy mixes for sustainability transitions (...)." (Diercks, 2019)</i>
0	Måns Nilsson, Nina Weitz	Governing trade-offs and building coherence in policymaking for the 2030 Agenda	2019	Politics and Governance	<i>"This article introduces a suggested comprehensive framework for identifying, assessing and governing trade-offs and enhancing coherence in public policy decision-making. The framework is based on a simple three-stage model of policy-making: understanding policy interactions (input), integrating policy-making (process), and assessing ex ante policy decisions (output) (...)" (Nilsson & Weitz, 2019)</i>

Annex Table 2 Example of Excel table to analyse articles through their abstracts

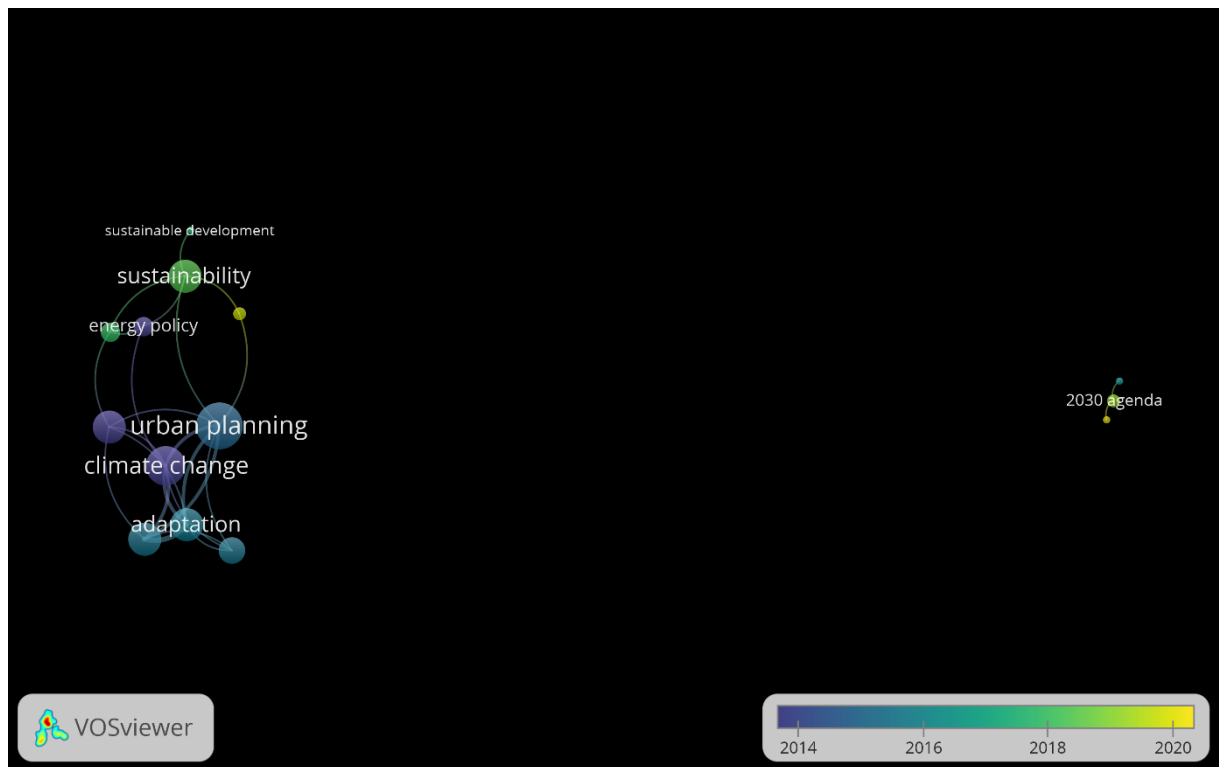
A2. VOSVIEWER DECISIVE IMAGES

The following images present the evolution of the Systematic Search step of the framework for literature selection. All images were obtained using the VOSviewer software and the literature used to obtain the network visualization was imported from the search in the Harzings' Publish or Perish software.

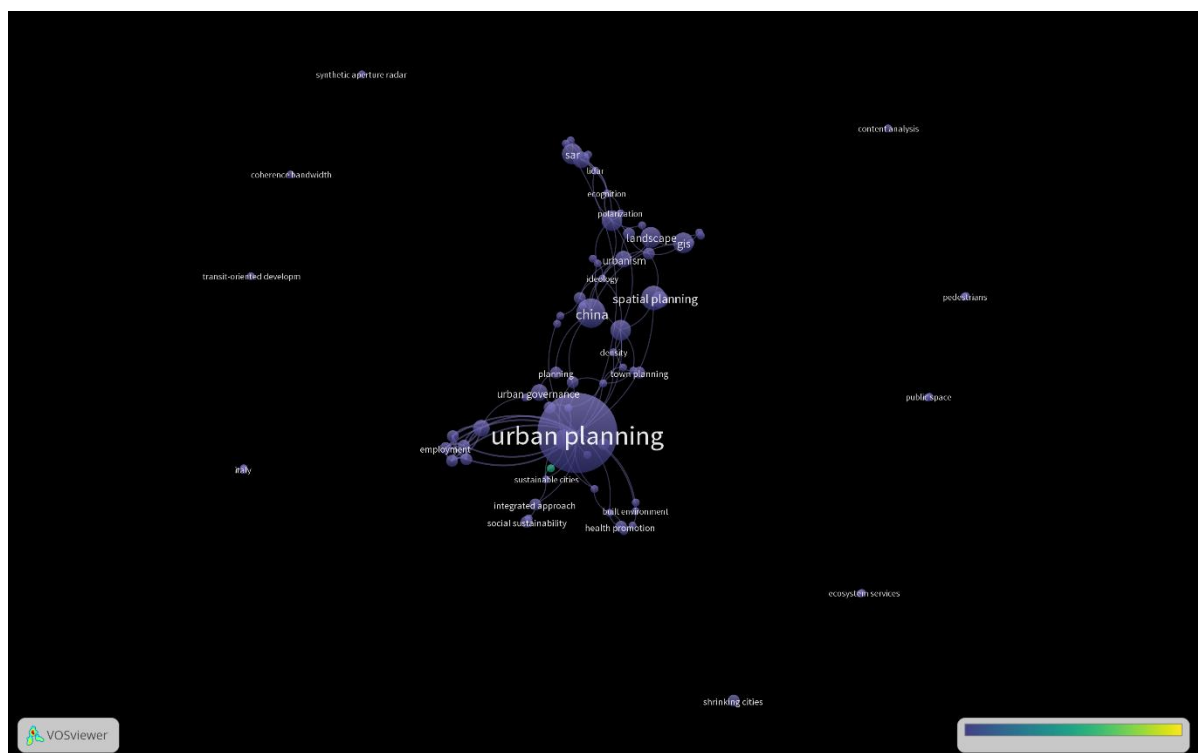
The description of the images identifies the date and the keywords or authors used.



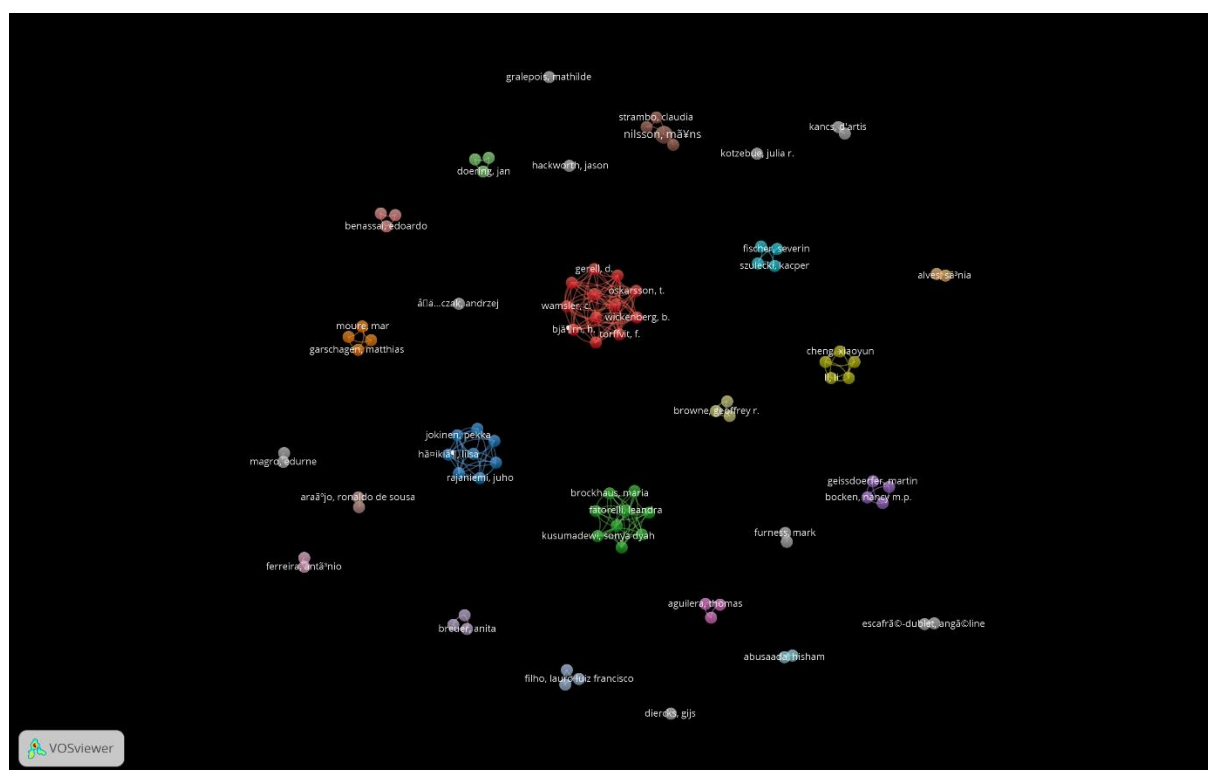
Annex Figure 7 February 18th -Police Integration keywords Network Visualization



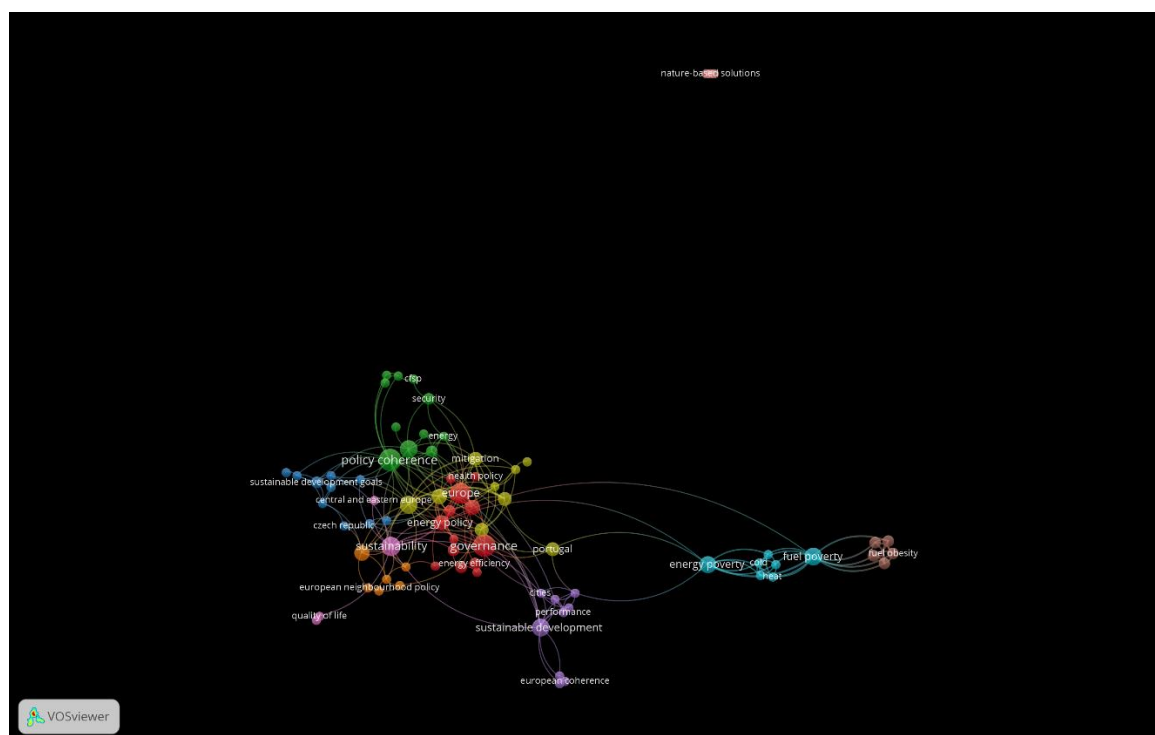
Annex Figure 8 February 21st Keywords overlay Visualization.



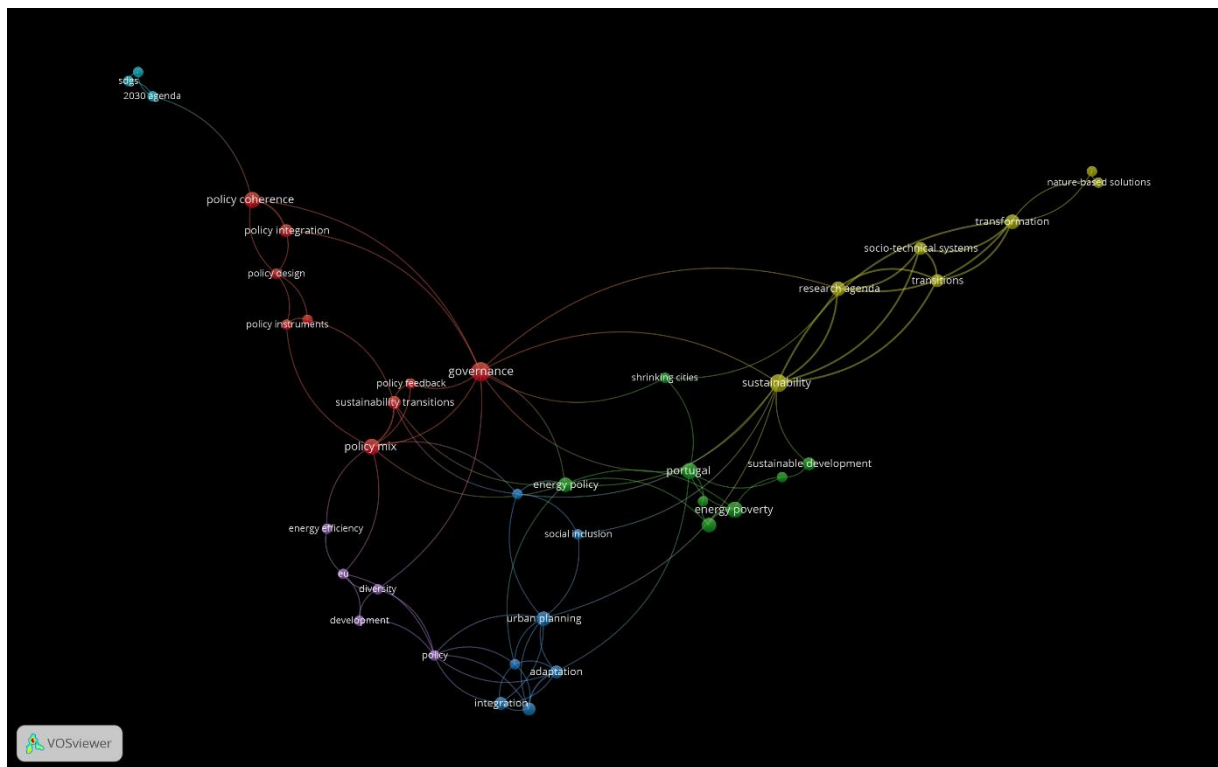
Annex Figure 9 February 23rd -Urban Planning Coherence Overlay Visualization



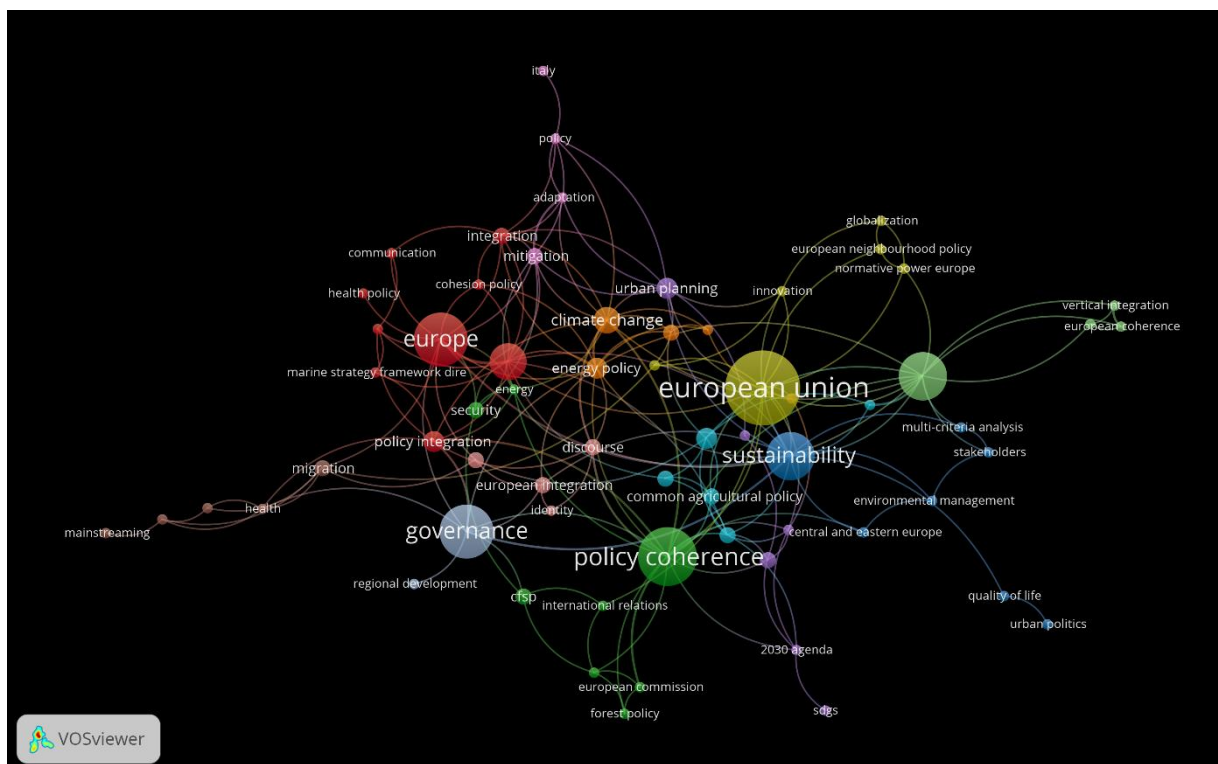
Annex Figure 10 March 1st -author of filtered literature network visualization



Annex Figure 11 March 13th -Keywords of policy coherence literature network Visualization



Annex Figure 12 March 17th -Keywords of literature network visualization



Annex Figure 13 March 24th - Keywords of literature saved on Mendeley Network Visualization

A3. MEASURES OF THE EXAMINED COUNTRIES BY TYPE

Country	National EP definition	Vulnerable consumer definition	Vulnerable consumer criteria
CY	Yes	Allowance beneficiaries of welfare stipends (based on Minimum Guaranteed Income or Public Aid), persons with physical disability, retired individuals with low incomes, blind individuals, families with three dependent children or more.	A, B, C
ES	No	There are three levels of vulnerable consumers, with different criteria and requisites but firstly, all vulnerable consumers of any kind must be beneficiaries of the Voluntary Price for Small Customer electricity tariff and a contracted power equivalent to or below 10 kW in their usual residence. The criteria involve low-income individuals, pensioners, large families and assistance from national social services.	A, B, C, D
PT	No	Beneficiaries of social welfare with some contract limitations.	C, D
BG	No	Household customers in whose property, supplied with electricity, live persons who for reasons of old age, health or income are exposed to the risk of social exclusion in relation to the supply and consumption of electricity and who benefit from social assistance measures to ensure the necessary electricity supplies.	A, B, C
LT	No	Consumers of electricity, who are entitled to receive monetary social assistance in accordance with the Law on Financial Social Assistance to low-income residents and who have the right to use additional guarantees provided to vulnerable consumers in the manner prescribed in national legislation.	C

Annex Table 3 Definitions of Energy Poverty and vulnerable consumers in the examined countries. A: Individual characteristics, B: Specific circumstances, C: Social welfare system, D: Related to energy consumption with contract limitations. (Source: Adapted from (Kyprianou et al. 2019))

Country	Measure	Timeline	Source	Aim	Geographic Scale
CY	Special tariff	-2006: Limited groups of vulnerable consumers. -2013, 2015 and 2016: Revised criteria to include more groups of vulnerable consumers.	Government	Reduced cost of electricity for specific groups of vulnerable consumers.	
	Electricity disconnection protection	-2015: Initially applied to all vulnerable consumer, revised in 2015 to only apply to vulnerable consumers with serious medical conditions.		Protection for all categories of vulnerable consumers from disconnection in critical times.	
ES	Social tariff for electricity	-2009: The measure freezes the electricity tariff at the time of the measure approval (2009) that was a remarkable discount, due to the important price increase in the following years. - 2012: 25% discount for specific consumers not mainly determined by income criteria - 2017: 40% discount for vulnerable households and prohibits the disconnection in severe vulnerable households when other administrations (regional or local) cover the remaining 50% of the bills.	National Government	Discount on the electricity bill for vulnerable households and protection of severely vulnerable households from disconnection.	National, same everywhere
	Prohibition of disconnection for medical reasons	- 2013: National law, only for household consumers that require electricity powered life support equipment		Law on the Electric Sector (Law 24/2013) establishes the prohibition of disconnection for consumers with severe health problems.	
	Precautionary principle in disconnection situations	- 2015: Local law promoted through a citizen initiative by social movements and civil society organisations	Regional Government	Prohibition of disconnection of electricity, gas and water supply for vulnerable households as certified by local social services in accordance with the precautionary principle.	Regional, Autonomous Community of Catalonia
PT	Social Tariff	- 2015: Local law promoted through a citizen initiative by social movements and civil society organisations	Government	Reduced cost of electricity and natural gas for specific groups of vulnerable consumers.	National, same everywhere
	Extraordinary Social Support	-- 2010: Vulnerable consumers, with a contracted power equal to or below 4,6KVA. - 2011: Vulnerable consumers, with contracts with		Reduced electricity and natural gas bill for specific groups of vulnerable consumers.	

LT		annual consumption equal to or below 500m ³ . - 2014: Electricity consumers with contracted power equal or below 6,9KVA, more categories and criteria. 2016: Both previous laws were revised to consider an automatic identification of vulnerable consumers through the social welfare system instead of by request of the consumers and with revised income criteria.	
	Reduced VAT on district heating and hot water	-2001: Reduced VAT rate (at 9%), temporary measure (extended annually). - 2017: Between June-September the VAT rate went back to 21%, but in October it was once again reduced to 9% and became a permanent measure.	Reduced VAT rate (9% instead of standard 21%) on district heating and hot water for households.
	Electricity disconnection protection	- 2012: Recognition of vulnerable electricity consumer, permanent measure. - 2017: Definition of vulnerable electricity consumer, permanent measure.	Protection of vulnerable consumers from electricity disconnection in critical times.

Annex Table 4 Consumer protection measures in the investigated countries (Source: Adapted from (Kyprianou et al. 2019))

Country	Measure	Timeline	Source	Aim	Geographic Scale
ES	Energy cost financial aid	- Local governments offer parts of their budgets through local social services. - Since the economic crisis in 2008 the demand increased dramatically and is now offered only in severe social exclusion situations.	Local governments	Emergency financial support to households, used or energy expenses in case of disconnection risk.	Local. Depending on municipality.
BG	Targeted aid for the	- 2000 - 2008: Limited groups of	Government	Financial aid for heating for five months	National, same

	new heating season	vulnerable consumers. - Since 2009 and ongoing: revised criteria to include more groups of vulnerable consumers.		(from 1 November to 31 March) for specific groups of vulnerable consumers. Aid differs for different vulnerable groups.	everywhere
LT	Compensations on heating, cold and hot water costs	- 2012: Mixed model of funding: 55 municipalities from state budget, 5 municipalities from own budget. - 2015: All funding from municipality budget. - 2017: Funding if heating costs exceed 10% of income (before it was 20% of income).	Municipality	Compensations on heating, cold and hot water costs for households with low income.	Administration on municipality level

Annex Table 5 Measures in the form of financial aids in the investigated countries. (Source: Adapted from (Kyprianou et al. 2019))

Country	Measure	Timeline	Source	Aim	Geographic Scale
	Saving Energy – Upgrading of Households	- 2014: Max grant €10.000 for apartments and €15.000 for houses. - 2018: Max grant €20.000 for apartments and €25.000 for houses	Government/EU	Energy upgrades and use of RES in households [66] - enhanced grant (75% instead of 50%) for vulnerable consumers.	
CY	Installation or replacement of solar water heating	- 2015: Only available for replacement, not initial installation. Annual budget: €200.000. - 2017: Initial installation or replacement. Annual budget: €60 0.000.	Government	Financial assistance (€175 / €350, depending on type of investment) for the installation or replacement of solar water heating systems.	National, same everywhere
	Solar energy for all / Energy production from RES for own use	- 2014: Net metering for houses/ local authority buildings and own production PV systems for commercial and industrial units. Max capacity of 20MW.		Promotion of solar energy (“Solar energy for all”), and with the 2017 revision also biomass/ biogas for own	

		- 2015: Max capacity increased to 40MW. - 2016: Autonomous PV systems also included. Max capacity increased to at least 63MW. - 2017: Net metering for houses and non-domestic consumers & own production PV, Biomass/Biogas systems for commercial and industrial units & Autonomous PV systems (at least 63MW).		use. Vulnerable consumers receive additional funds.	
	Soft loans for Photovoltaics	- 1 million euros for loans with favorable terms for PV installations in the Aradippou municipality	Municipality	Loans with favourable terms for the installation of PV systems on homes. Cooperative Bank and the regional Chamber of Commerce and Industry also involved.	Regional
ES	Program for the promotion of building	- 2013–2017: National budget was c. €888 million combined with partial regional investment. Amount of subsidy determined based on socioeconomic criteria. - 2018–2021: National budget will be c. €1.4 billion combined with partial regional investment. Specific groups of individuals (e.g. large or single-parent families) at risk have priority. Renewable	National government/ Autonomous Communities	Financial assistance to households for energy efficiency works.	National, same everywhere
	Renewable energy self-consumption financial support	- Autonomous communities use parts of their budgets to create schemes on a local basis, e.g. in Catalonia, subsidies for energy storage systems with batteries associated to PV self-consumption installations		Build or improve RES self-consumption systems. Social housing or small municipalities can receive better economics aids.	Regional – more benefits in rural areas

	Regional energy efficiency programs	- 2017: Initiation of schemes promoting energy efficiency, e.g. in Catalonia, subsidies to improve accessibility and knowledge of the state of residential buildings managed by the regional Housing Agency.		Spanish regions provide financial assistance for energy efficiency renovations and renewable energy.	National, but not the same everywhere
	Housing renovation grants	- 2017: Final approval for “Barcelona Right to Housing Plan 2016–2025 ??”, with a budget of app. €3 billion-	Local Governments	Improvements in the housing conditions including targets to increase energy efficiency levels to protect households against EP	Local (Barcelona)
	Programs PAREER	- 2015–2017: Budget for 1st call €126,5 million, budget for 2nd call €78 million	National government/ Institute for the Diversification and Saving of Energy	Energy efficiency improvements and switch of conventional energy sources with biomass/geothermal energy. Additional funds may be provided based on social criteria.	National, same everywhere
PT	Electrical Energy Consumption Efficiency	- 2007–2012: 156 measures (24 on the residential sector) with a budget of €50.3 million. - 2013–2018: 145 measures (16 on the residential sector) with a budget of €40 million.	Regulatory Authority for Energy Services	Improve the efficiency of electricity consumption, through actions taken by several agents in the different energy sectors.	National, same everywhere
	Energy Efficiency Fund - Energy Efficiency in Buildings	- 2012: Budget of €2 million, only for window replacement and solar thermal systems installation. - 2015: Budget of €1 million, for external and	Government	Energy efficiency measures such as windows, heating and hot water systems replacement everywhere	National, same everywhere

	roof insulation. - 2016: Budget of €1.1 million, for solar hot water systems, windows, wall insulation, pavements and roofs. - 2018: Budget of €1.5 million, for measures of solar hot water system rated A; replacement of existing water heating systems by new A + ones; replacement of windows, insulation in internal and external walls, roofs and indoor and outdoor pavements		and wall and roof insulation, for residential dwellings and service buildings.	
Electricity generation from RES for self-consumption	- 2002: Power to be delivered to the grid could not exceed 150 KW; and own consumption or the supply to third parties would be at least 50% of the electricity generated. - 2014: Electricity generated by PV systems should be used mostly for the households' own benefit, with systems until 1500 W avoiding the payment of taxes.		Electricity generation, for own use in the location associated with the respective everywhere producing unit, with or without connection to the grid supported on RES.	
Improved Comfort in Vulnerable Households	- 2007: Improvements are identified at the building level and at the equipment level. - 2014: Eligibility criteria introduced and different measures according to regions.	Municipal	Improvement of the housing comfort of vulnerable households.	Mainland Portugal, especially in inland areas with more elderly people.
Integrated Action Plans for Disadvantaged Communities (PAICD) & Energy	- 2017: Rehabilitation of 17 social neighborhoods (10 PAICD applications and 7 EE applications) and a total of 1632 households. Combined budget of over €16 million through interventions in the building's	Government	Physical, social and economic regeneration of social neighborhoods (designated territories of disadvantaged	Social neighborhoods within municipalities

BG	efficiency (EE) measures	shell, common areas and networks of water and electricity (PAICD). For the EE applications, beneficiaries are municipal bodies that own or operate social housing, with a non-refundable support rate of up to 85%, except in the Lisbon region where this figure drops to 50% due to the rules for the distribution of funds.	communities). Also, interventions in buildings to improve energy efficiency and use of RES	
	Instrument for the Urban Rehabilitation and Revitalization (IFRRU 2020)	- 2015–2023: Budget of €252 billion from which €106 billion are from EU funds. Intended for the complete rehabilitation of buildings of 30 years of age or more, abandoned spaces and industrial units, and also for interventions in private fractions inserted in social housing buildings.	Financial products with favorable terms, designed to support urban rehabilitation and energy efficiency, with emphasis on social housing	
	Energy efficiency and RES fund	- 2006–2011: 123 projects with a total budget of €19 million (av. €154,500/project). - 2012–2017: 72 projects with a total budget of €13 million (av. €180,600/project).	Financial products (loans, cessions and guarantees) to municipalities, corporate everywhere clients and private individuals towards energy efficiency investments.	National, same everywhere
	Introduction of energy saving technologies in industry	- 2007–2013: Total budget of €1.16 billion. - 2014–2020: Total budget of €1.39 billion.	Subsidies for energy audits in small and medium-sized enterprises; introduction of everywhere energy saving technologies and RES in industry.	

Government/ EU

LT	Promotion of RES	- 2011: Modernization programme: promotion of RES for residential buildings. - 2012: All buildings must be constructed prior to 1993. - 2013: For residential RES installations, energy produced must be for self-consumption. - 2014–2016: Introduction of grant limits (up to 30% of investment). - 2017: Subsidy up to 25%.	Government	Installation of RES in residential sector (Special Program for Climate Change funds).
	Multifamily Buildings Renovation Program (Special Programme for Climate Change)	- 1996–2004: World Bank project for modernization, budget of 70 million LT (state funds). - 2005–2010: Multi-apartment Buildings Renovation Program, budget of 325 million LT. Only for buildings constructed prior to 1993. Low-income families receive a 100% subsidy. - 2010–2020: Multi-apartment Buildings Renovation Program through JESSICA, budget of €227 million. Only for buildings constructed prior to 1993.	Government/ EU	Soft loans (fixed 3% interest rate) to promote energy efficiency and use of RES in everywhere multifamily buildings: grant (up to 100%) for vulnerable consumers (already receiving financial aid) and partial VAT exemptions.
	Feed-in tariff for Photovoltaics	- 2011: Installed capacity of solar PV is 0 MW. - 2012: Feed-in tariff for solar PV up to 30 KW was 0.42 €/KWh (three times higher than electricity price). - 2013: Feed-in tariff for solar PV up to 10 KW decreased to 0.16 EUR €/KWh, feed-in tariff only for surplus electricity. Quota of 70 MW Solar PV was reached.	Government	Solar power plants, decentralized electricity generation.

Energy production from RES for own use	- 2015: Definition of prosumer, promotion of prosumers' PV up to 10 KW, except public and local authority buildings up to 50 KW. - 2017: Prosumers' PV, wind, and biomass up to 10KW (natural persons) and up to 100 KW (legal persons). - 2018: Since May four types of net metering for prosumers (natural and legal persons) of PV, wind, and biomass installations	Solar PV, Wind, and Biomass installations for own production.
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Annex Table 6 Energy savings measures in the investigated countries. (Source: Adapted from (Kyprianou et al. 2019))

Country	Measure	Timeline	Source	Aim	Geographic Scale
ES	Energy advice points	- The first Energy Advice Points were in Barcelona, and were opened in 2017	Local Governments	Offer advice to the households in energy service issues, such as how to improve their energy efficiency, check if the energy contract is the best for their needs or how they can protect their energy rights in case of disconnection risk.	Local. Depending on municipalities

Annex Table 7 Information provision measures in the investigated countries (Source: Adapted from (Kyprianou et al. 2019))

Estimation of relative score

<i>MS</i>	<i>EP definition</i>	<i>Energy vulnerable consumer</i>	<i>Consumer protection measures</i>	<i>Financial aids</i>	<i>Energy savings</i>	<i>Information provision</i>
CY	Yes	Yes	2/9	–	4/21	–
ES	–	Yes, contract limitations	3/9	1/3	5/21	1/1
PT	–	Yes, contract limitations	2/9	–	6/21	–
BG	–	Yes	–	1/3	2/21	–
LT	–	Yes	2/9	1/3	4/21	–

Annex Table 8 Criteria and proportion of each Member State participation in total number of measures per category (Source: (Kyprianou et al. 2019))

<i>MS</i>	<i>EP definition</i>	<i>Energy vulnerable consumer</i>	<i>Consumer protection measures</i>	<i>Financial aids</i>	<i>Energy savings</i>	<i>Information provision</i>	<i>Relative score</i>
CY	X	X	X		XX		5
ES		XX	XX	X	XXX	X	9
PT		XX	X		XXXX		7
BG		X		X	X		3
LT		X	X	X	XX		5

Annex Table 9 Ranking for each of the considered criteria. (Source: (Kyprianou et al. 2019))

<i>MS</i>	<i>Differentiation for vulnerable consumer groups</i>	<i>Differentiation for vulnerable consumer groups (%)</i>	<i>Regulation on national level</i>	<i>Regulation on national level (%)</i>
CY	4/6	67%	5/6	83%
ES	6/10	60%	5/10	50%
PT	5/8	63%	6/8	75%
BG	1/3	33%	3/3	100%
LT	3/7	43%	6/7	86%

Annex Table 10 Percentages of national regulation and distinction for vulnerable consumers. (Source: Adapted from (Kyprianou et al. 2019))

A4. ELPCPE FRAMEWORK

Annex Table 11 ELPCPE framework of European and Nation Instruments

European	
	Clean Energy for all Europeans Package (CEP)
	Climate and Energy Package 2030
	Regulation (UE) 2018/1999
	Directive (UE) 2018/844
	Directive (UE) 2019/944
	European Green Deal
	Commission Recommendation (EU) 2020/1563
	EPOV
	Energy Poverty Advisory Hub (EPAH)
National	
	<i>Roteiro para a Neutralidade Carbónica 2050 (RNC 2050)</i>
	<i>Plano Nacional Energia e Clima para o horizonte 2021-2030 (PNEC 2030)</i>
	<i>Estratégia de Longo Prazo para a Renovação dos Edifícios (ELPRE)</i>
	<i>Estratégia Nacional de Combate à Pobreza</i>
	<i>Programa de Arrendamento Acessível (PAA)</i>
	<i>Bolsa de Imóveis Públicos</i>
	<i>Reabilitar para Arrendar – Habitação Acessível</i>
<i>Tarifa Social de fornecimento de energia</i>	<i>Decreto-Lei nº 138-A/2010, Decreto-Lei nº 101/2011, Decreto-Lei nº 172/2014, Decreto-Lei nº 138-A/2010, Lei nº 7-A/2016, artigo 293.º da Lei n.º 2/2020, Decreto-Lei n.º 100/2020, Portaria n.º 178-B/2016, Portaria n.º 178-C/2016, Portaria nº 45-B/2021, Portaria nº 12/2021)</i>
	<i>Decreto-Lei n.º 60/2019</i>
	<i>Decreto-Lei n.º 74/2020,</i>
	<i>Lei n.º 7/2020</i>
	<i>Lei n.º 18/2020</i>
	<i>Portaria n.º 6/2021</i>
	<i>Decreto-Lei n.º 6-E/2021,</i>
	<i>Regulamento da ERSE n.º 180/2021</i>
	<i>CINERGIA</i>
	<i>Observatório da Energia</i>
	<i>Poupa Energia</i>
	<i>Projeto “Consumidor Informado Consumidor Poupado”</i>
	<i>LIGAR</i>
	<i>Índice de Vulnerabilidade à Pobreza Energética (IVPE)</i>
	<i>Gabinete de Aconselhamento de Energia da DECO</i>
	<i>Porto Energy ElevatoR</i>
	<i>POWERPOOR</i>

A5. ELPCPE ACTORS' ACRONYMS

- **ELPRE** – *Estratégia de Longo Prazo para a Renovação dos Edifícios*
- **EPAH** – *Energy Poverty Advisory Hub*
- **ERSE** – *Entidade Reguladora dos Serviços Energéticos*
- **FA** - *Fundo Ambiental*
- **IHRU** - *Instituto da Habitação e da Reabilitação Urbana*
- **INE** – *Instituto Nacional de Estatística*
- **IPSS** - *Instituição Particular de Solidariedade Social*
- **MAAC** – *Ministério do Ambiente e da Ação Climática*
- **MCTES** - *Ministério da Ciência, Tecnologia e Ensino Superior*
- **ME** – *Ministério da Educação*
- **METD** – *Ministério da Economia e da Transição Digital*
- **MF** – *Ministério das Finanças*
- **MIH** – *Ministério das Infraestruturas e da Habitação*
- **MTSSS** – *Ministério do Trabalho, Solidariedade e Segurança Social*
- **PNEC** - *Plano Nacional Energia e Clima*
- **PPEC** - *Plano de Promoção de Eficiência no Consumo*
- **PRR** – *Programa de Recuperação e Resiliência*
- **PT 2030** - *Programa Operacional Portugal 2030*
- **RCM** – *Resolução de Conselho de Ministros*
- **RNAE** - *Associação das Agências de Energia e Ambiente*
- **RNC** - *Roteiro para a Neutralidade Carbónica*
- **SS** – *Segurança Social*