NOVA SCHOOL OF SCIENCE & TECHNOLOGY

DEPARTAMENT OF ELECTRICAL AND COMPUTER ENGINEERING

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BSc in Electrical and Computer Engineering

ASSESSING ENERGY POVERTY VULNERABILITY IN THE EUROPEAN UNION ISLANDS

MASTER IN RENEWABLE ENERGY ENGINEERING

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Abstract

Energy Poverty (EP) is a situation in which households experience inadequate levels of energy services such as space heating and cooling. EP is a complex multidimensional phenomenon and one of the most significant societal challenges in the European Union (EU), currently affecting millions of people, resulting in negative consequences for the health, quality of life, and well-being of the population. Studies and metrics to identify and measure energy poverty usually focus on a country level. Although several analyses have been developed at higher resolution spatial scales, some territorial contexts, such as the EU Islands, are still overlooked. The present work aims to assess energy poverty vulnerability among EU Island regions by focusing on available metrics and indicators frequently referred to in literature to measure this state of condition. Altogether, 13 energy poverty indicators were analysed for 19 NUTS2 regions, covering 11 member states. The method used to evaluate energy poverty in the EU islands involves the development of three types of analysis carried out for each indicator, which could potentially lead to awareness about energy poverty vulnerability. Firstly, it was provided an overview with an EU Map concerning each indicator's results, aiming to detect the main regional hotspots. Secondly, the evolution of the results for each region with a three-year time horizon was explored. Finally, the variation between regions for each indicator was calculated to determine whether the performance on the island NUTS2 regions is lower, higher, or equal when compared to the average value of their matching overall country data. Results reveal a wide-ranging distinction across the EU island regions, which can be explained by the differences in geography, climate, income levels, and local-policy action. Considering the EU and several member states' goals on tackling energy poverty, as well as improving energy efficiency, such analysis may contribute with some valuable insights for the development of regionally tailored policy to eradicate energy poverty in the EU islands, towards an improvement in the population wellbeing and lower expenditure on health care.

Keywords: Energy Poverty; Fuel Poverty; Vulnerability; EU Islands; Regional Scale

RESUMO

A Pobreza Energética é um fenómeno multidimensional bastante complexo e um dos maiores desafios inerentes à União Europeia (UE) que, atualmente, afeta milhões de cidadãos e, que resulta em consequências bastante negativas ao nível da saúde, qualidade de vida e bem-estar da população. Os consumidores em situação de pobreza energética experienciam níveis inadequados dos principais serviços energéticos como arrefecimento e aquecimento. A maioria dos estudos e índices desenvolvidos para monitorizar e identificar pobreza energética foca-se, normalmente, apenas ao nível dos países. Apesar de várias análises terem já sido desenvolvidas com resoluções espaciais mais complexas, alguns territórios como as ilhas constituintes da União Europeia continuam ainda por explorar face a este fenómeno. O presente estudo tem como principal objetivo a análise de Pobreza Energética existente nas Ilhas pertencentes à UE, através do foco em métricas e indicadores frequentemente referidos na literatura para identificar este estado de condição. No total, foram analisados 13 indicadores de pobreza energética relativos a 19 regiões NUTS2, correspondentes a 11 estados-membros distintos. O método utilizado para avaliar pobreza energética nas Ilhas da UE consiste no desenvolvimento de três tipos de análise diferentes para cada indicador, que poderão conduzir a uma tomada de consciência acerca da condição de vulnerabilidade a pobreza energética existente nestes territórios. Primeiramente, foi fornecida uma perspetiva ao redor da União Europeia através de mapas para cada indicador, onde foi possível detetar os principais hotspots. Em segundo lugar, foi explorada a evolução dos resultados para os indicadores relativos a cada região com um horizonte temporal de três anos. Por fim, foi calculada a variação entre as diferentes regiões, com vista a determinar se a performance nas Ilhas (NUTS2) é menor, maior ou igual quando comparando com o valor médio dos seus países associados, para cada indicador. Os resultados revelam uma ampla distinção nas diferentes ilhas da UE, que pode ser explicada em função das disparidades existentes ao nível da geografia, clima, rendimentos e políticas locais. Tendo em conta os objetivos da UE em acabar com a pobreza energética, assim como melhorar a eficiência energética, tal análise poderá contribuir perspetiva bastante valiosas para o desenvolvimento de políticas regionais à medida. Desta forma, através da erradicação de pobreza energética nas ilhas da UE, será possível atingir uma melhoria do bem-estar da população e uma diminuição das despesas associadas aos cuidados de saúde.

Palavras-chave: Pobreza Energética; Vulnerabilidade; Ilhas Europeias; Escala Regional

INDEX

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

BSO	Building Stock Observatory
CDD	Cooling Degree Days
CoM	Covenant of Mayors
EC	European Commission
EDEPI	European Domestic Energy Poverty Index
EEPI	European Energy Poverty Index
EFTA	European Free Trade Association Country
EP	Energy Poverty
EPAH	Energy Poverty Advisory Hub
EPOV	Energy Poverty Observatory
ESA 2010	European System of National and Regional Accounts
ETEPI	European Transport Energy Poverty Index
EU	European Union
EU-27	European Union Member States (total of 27)
EU-LFS	European Labour Force Survey
EU-SILC	European Union Statistics on Income and Living Conditions
FP	Fuel Poverty
HBS	Household Budget Surveys
HDD	Heating Degree Days
MS	Member State
NUTS	Nomenclature of Territorial Units for Statistics
R2E	Right to Energy Coalition
UK	United Kingdom
WP	Work Package

1

INTRODUCTION

Energy Poverty (EP) is often defined in Europe as a state where households experience inadequate levels of essential energy services such as adequate warmth and cooling. Therefore, EP is a "growing societal challenge that puts the welfare of many European citizens at risk", resulting in negative consequences for the population's health, quality of life, and wellbeing [1]. According to Eurostat, in 2020, 7.5% of the Europeans were unable to afford to keep their homes adequately warm, expressing energy poverty as a major challenge and policy priority for the European Union (EU) [1].

Adequate warmth, cooling, lighting, and efficient energy systems are essential services for social inclusion, guaranteeing a decent standard of living and health. Thus, tackling energy poverty might contribute to multiple benefits, including fewer expenses on health, improved comfort, the well-being of households, and improved household budgets with fewer expenditures on energy bills. Such benefits could contribute directly to an economic boost leading to growth and prosperity in the European Union. The European Commission Recommendation 2020/1563 on energy poverty states that the EU Member States shall take appropriate measures to tackle it anywhere it is identified [2]. Furthermore, Member States are responsible for protecting vulnerable consumers, including tailored policies and outlined frameworks for reducing energy poverty in their National Energy and Climate Plans. Under the climate-neutral objectives announced by the European Commission on the 'Fit for 55' package, which covers a wide range of policy areas such as energy efficiency and renewable integration, a new Social Climate Fund (€72.2 billion for the period 2025-2032) was settled down to support the Member States promoting fairness and solidarity, mitigating at the same time the risk of energy poverty [3].

Given that energy poverty is a multidimensional and multifaceted phenomenon, it is not easy to choose a single indicator that can reflect all its sides. This demands close support from some entities like the EU Energy poverty Advisory HUB (EPAH), OpenExp, and Trinomics, which have provided expertise and knowledge (through data reports) in an open-access way, that can then be useful for the policymakers to develop tailored and target policies to eradicate energy poverty.

1.1 Topic Significance

Among literature [4], energy poverty is often described as a direct consequence of some factors such as energy inefficient housing stock, low household income levels, high energy prices. The highest rates of excess winter deaths are found in the warmest countries, where buildings have lower energy performance and lack access to heating systems, which lead to thermal discomfort. Sweden, Denmark, and Finland, which are well-known countries for the extreme temperature conditions in the winter, tend to have less percentage of excess winter deaths when compared to the warmest countries like Malta, Portugal, and Cyprus [5]. Smith et al. [5] leave clear the consequences of thermal discomfort, which can be related to the presence of energy poverty and can lead to serious health complications:

- **Higher levels of stress and anxiety:** associated with energy-poor quality building living conditions, social deprivation, risk of poverty, and inability to afford energy bills.
- **Poor health from an early age:** children living in poor conditions tend to have respiratory complications, like asthma.
- **Illness and early death among the elderly:** where inadequate housing conditions could lead to higher rates of excess mortality. Besides winter mortality rates, associated deaths with higher temperatures in the summer are an increasing concern, especially at a time of remarkable climate change. Additionally, exposure to cold, damp, and mold can bring serious health impacts.

Energy Poverty is not only a problem in the winter time. With global temperatures rising, heatwaves, cold spells, and other extreme events are becoming the new normal. In Europe, in the summer of 2003, was estimated a number of 70,000 additional deaths due to an extreme weather event related to excessive heat [6]. In contrast with Figure 1, the Cooling Degree Days (CDD [1]) values were more than two times higher in 2020 (99) when compared to 1979 (37), and so the trend expresses an increase of this value over time. From here, the number of days on which people need to use energy systems for cooling are increasing dramatically [7].

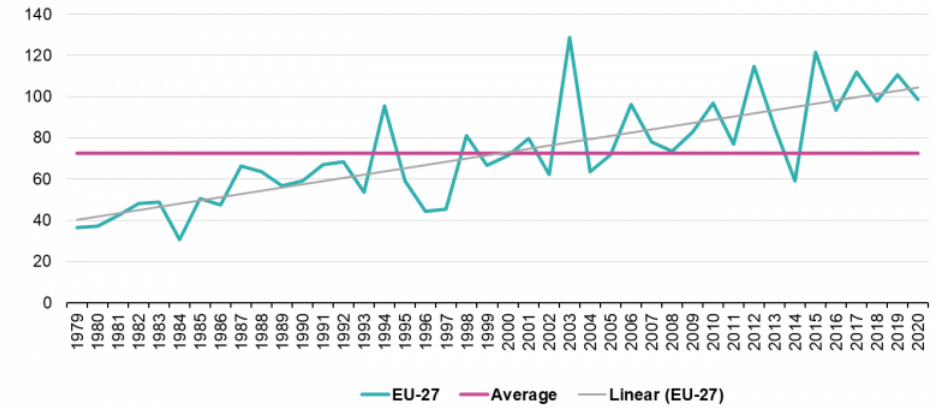

Figure 1 - Cooling Degree Days in EU-27, 1979-2020. Source:[7]

[1] **Cooling Degree Days (CDD):** weather-based technical indexes designed to describe the energy requirements of buildings in terms of cooling requirements.

Energy poverty can also result from poor energy efficiency, especially at the level of buildings-related performance. The European Commission considers that people in inefficient buildings are more exposed to weather events such as cold spells or heat waves [8]. Speaking of heat-waves, not all households have air conditioning systems, and some of them cannot even use such systems as they are unable to afford associated energy bills. From here, several European households may experience summer discomfort in summer as the temperatures are rising too. Southern European Countries are particularly at risk with this situation, where the quality of the buildings tends to be poorer by trapping heat inside due to the use of inappropriate building materials that absorb heat rather than reflect it [5], [6].

High energy costs and consequent delays in the payment of bills can worsen energy poverty conditions even further, with people falling into a situation where they cannot get access to proper energy services [9]. Actually, about 6.2% of European Households faced delays in paying their utility bills on time in 2019 [10]. The awareness is rising in Europe, where the incidence of energy poverty has wide-ranging variation across the EU member states - while the share of the population with low income and high housing expenses affects 67% of the population in Greece, it affects only 12% of France citizens, with an EU average of 22% [11]. Considerable variation is also found within Member-states, relating to different configurations of the problem, calling for in-depth studies to analyze its magnitude at smaller scales [12].

1.2 Objective: European Union Islands

Although studies and metrics usually focus on a country level, several analyses have been developed at higher resolution spatial scales. Even so, some territorial regions, such as the EU Islands, are still overlooked. That's the major goal of this work, i.e., **Assessing Energy Poverty Vulnerability in the European Union Islands**. Through disaggregated assessments to obtain a more detailed and insightful perspective, domestic energy poverty situations related to energy services will be addressed. The development of such analyses is mandatory to identify the main hotspots for local action, potentially influencing policy in social, economic, and climate dimensions.

Most of the EU Islands suffer from several handicaps to growth and development where "energy insularity places the affected regions in Europe at an economic disadvantage since they are often heavily dependent on fossil fuels" [13]. Additionally, the state of insularity has a direct effect on price discrepancies, which can set disparities across European regions [13], [14]. Other challenges include the small market size, which does not allow economies of scale, and isolation, which involves high installation and operating costs for companies, households, and the state. These barriers often result in higher energy costs and price variations due to the dependence on imports [15], [16].

Specifically, according to the research article on "Insularity and economic development: a survey" [17], the state of insularity can be defined by three interconnected dimensions: smallness, remoteness, and isolation/vulnerability. The major consequences of smallness are the limited size of domestic markets, which implies a low domestic demand [17]. Regarding the low domestic demand, the input prices in the production process could be relatively higher. On the other dimension, there is also the remoteness, which in the case of islands, can be enhanced by smallness given that a minor economy would require small "cargos", with higher per-unit costs, due to the trading difficulties in transport and communication (geographical limitations). On the other hand, islands are exposed to economic and environmental shocks, like excessively high temperatures, sea-level rise, and storms, compared to the mainland [17], [18]. In this sense, the outermost regions like the EU Islands are a challenge to European integration, where tackling energy poverty takes on vital importance to maintain the territorial cohesion model of the EU.

The assessment of energy poverty in the EU Islands can strengthen future national and regional strategies, aiming to promote effective action in local contexts, which is one of the priorities defined in the 'Clean Energy for All Europeans Package' [11]. Initiatives focusing on the local level, such as the 'Clean Energy for EU Islands' [19] and the EU Energy Poverty Advisory Hub (EPAH)[1], are valuable opportunities to produce useful knowledge and tools to tackle and prevent energy poverty.

This analysis may contribute with valuable insights to assessing energy poverty in the EU Islands. It is particularly relevant when considering the pressing goals at the EU level for its reduction, together with energy efficiency improvement and decarbonization of the economy in 2050 [20]. If regional policies are evidence-based and supported by sound metrics and knowledge, they can contribute with multiple benefits to a better society, including potential lower expenditure on health care, air pollution, and improved population wellbeing towards sustainable development in these regions.

Depending on the data availability, the assessment of energy poverty conditions in the different EU island regions will take into account indexes/indicators that can lead to an insight into energy poverty vulnerability. To compare the results obtained for the EU Islands, the outcomes related to the indicators for each Member-State will also be considered to perform an analysis between these different regions, ideally linking the obtained results with some key indexes developed by research entities on this matter.

[1] https://energy-poverty.ec.europa.eu

1.3 Thesis Structure

The second chapter is entirely dedicated to the literature review in relation to the main purpose of the present work: Assessing Energy Poverty Vulnerability. An introduction to the topic of energy poverty around Europe is presented, where the main policies and key initiatives and regulations by the European Union to tackle this challenge are shown. Then, some Member States' specific concepts and definitions of what it means to be in energy poverty are presented, where a list of official definitions can be seen. Also, in this chapter, the most relevant publications and studies that contributed to the development of this work are explored, specifically about indicators that can be used to detect situations of vulnerability associated with the condition of energy poverty, where finally, the main source of data for the present study is referred.

The third chapter presents the adopted methodology to assess energy poverty vulnerability in the European Union Islands. All the steps taken to carry out the study are explained in detail. Here, it can be noted how the approach was established to define the major target of this work (EU Islands) and which regions were selected to be studied. Following this, the methodology considered for selecting the energy poverty indicators for data extraction regarding each region can also be seen as well as some procedures adopted during the data extraction stage. Lastly, it will be provided an explanation on the three types of analysis that were conducted as well as an illustration of a representative flowchart of the adopted methodology.

The fourth chapter analyses the energy poverty situation in each of the eleven member states associated with the island regions under study.

Towards the end of the present work, in chapter 5, the study's main results are presented and discussed. To detect situations of energy poverty vulnerability, in this chapter, three types of analysis carried out for each indicator can be found: an EU Map overview, an assessment of the evolution over a 3-year time horizon for each NUTS2 Region, and finally, a comparison of results between the island regions and the matching countries average values. This analysis is then followed by the subchapter "Overall Discussion", where a relation between the results of the different indicators is present to reveal and support the existence of energy poverty vulnerability situations. The final chapter (6) presents the conclusions of this work, where the main weaknesses and opportunities for improvement are identified, as well as a suggestion for the next steps and future related work.

2

LITERATURE REVIEW

This chapter reviews the pertinent literature and research focusing on energy poverty. The first section presents a general overview of energy poverty in the European Union, addressing policies, regulations, and leads set in motion to tackle this complex phenomenon. The second section will entirely explore the best-known concepts and official definitions of this matter. In the third section, key publications and datasets will also be reviewed to explore some of the metrics and methodologies developed by the scientific community and important key actors to combat this problem.

2.1 Energy Poverty Concepts & Definitions

Thomson et al. [21] investigated the debate regarding fuel and energy poverty terminology. They concluded that the term energy poverty is most commonly used to define domestic energy deprivation rather than Fuel Poverty (FP). Nevertheless, the terms are used interchangeably within the same context. Since there is not any EU guidance on how to define vulnerable consumers, the term Energy Poverty can also be identified via terms such as Fuel Poverty or Energy Vulnerability. The concept of energy poverty and vulnerable consumers was addressed for the first time by the European Commission in 2009, with the Directives 2009/72/EC and 2009/73/EC. Moreover, the EU has also launched an important report [22], by exploring the incidence of vulnerability across the EU-28, Iceland, and Norway, by explaining the factors of any observed vulnerability in these key markets. Since then, various definitions of energy poverty have been described in the related literature and across Member States' official definitions, although it has not been established as an official standard in the European Union. This wide range of related EP concepts and definitions will be reviewed and presented in this sub-chapter. For the review of EP definitions across the EU, it was considered the study developed by Castaño-Rosa et al. [23], which details some of the countries that do have an official definition of EP as well as some of the best-known concepts on energy poverty around Europe. Trinomics's report on "Selecting Indicators to Measure Energy Poverty Under the Pilot Project' Energy Poverty" [24] was also important for the current compilation, presented in Table 1, which lists key definitions of EP adopted by the Member States.

Table 1 - Overview of Definitions of Energy Poverty

Member State	Definition	Reference
France (2009)	**Energy Poverty:** A person who encounters difficulties in his/her accommodation in terms of energy supply related to the satisfaction of elementary needs. This is due to the inadequacy of financial resources or housing conditions.	[11]
Cyprus (2014)	**Energy Poverty:** The situation of customers who may be in a difficult position because of their low income as indicated by their tax statements in conjunction with their professional status, marital status, and specific health conditions and therefore, are unable to respond to the costs for the reasonable needs of the supply of electricity, as these costs represent a significant proportion of their disposable income.	[25]
Slovakia (2012)	**Fuel Poverty:** Status reached when average monthly expenditures of a household on the consumption of electricity, gas, heating, and hot water production represent a substantial share of the average monthly income of the household.	[26]
Scotland (2018)	**Energy Poverty:** A household is in EP if its required fuel costs are more than 10% of household net income after deducting housing costs, and the remaining household net income after the payment of fuel costs and childcare costs (if any) are also insufficient to maintain an acceptable standard of living for the household.	[27]
United Kingdom (2010 Definitions for Northern Ireland, Scotland, and Wales)	**Fuel Poverty:** A household is said to be in fuel poverty if it needs to spend more than 10% of its income on fuel to maintain an adequate level of warmth.	[28]
United Kingdom (2013 Definition for England)	**Fuel Poverty:** A household is considered to be fuel poor if they have required fuel costs that are above average (the national median level) and having spent that amount, hence they would be left with a residual income below the official poverty line [60% median income]	[28]
Ireland (2014)	**Energy Poverty:** Situation whereby a household is unable to attain an acceptable level of energy services (including heating, lighting, etc.) in the home due to an inability to meet these requirements at an affordable cost.	[29]
England **(2018)**	**Fuel Poverty:** A household is fuel poor if: they have required fuel costs that are above average (the national median level) were they to spend that amount, they would be left with a residual income below the official poverty line. Household income, household energy requirements, and fuel prices are important elements to determine whether a household is fuel poor or not.	[30], [31]
Spain (2019)	**Energy Poverty:** Situation of a household in which basic energy supply needs cannot be met as a result of an insufficient level of income and may be aggravated by energy inefficient housing.	[32]

Portugal (2021)	**Energy Poverty:** Inability to maintain the dwelling with an adequate level of essential energy services, due to a combination of low income, low energy performance of the dwelling, and energy costs. (Draft-Version)	[33]

In order to tackle the problem, the European Commission must develop a comprehensive methodology to give a snapshot of energy poverty and support Member States with their strategies to tackle this problem in more detail. Under the Third Energy Package, Member States should define vulnerable consumers in the energy markets [24]. The Insight_E project report from May 2015 [34], which was a project funded by the European Commission under the 7th Framework Program for Research and Technological Development (2007-2013) focusing on energy poverty and vulnerable consumers, compiles the main drivers and key indicators on energy poverty addressed in several studies. According to the Insight_E project, these primary drivers of EP are a combination of three main causes:

- **High energy prices,** clearly affect the ability of consumers to afford adequate services to ensure their well-being;
- **Low-income levels,** which can set vulnerability, where the low income may constrain the ability of the consumer to maintain the bills associated with adequate services;
- **Low levels of energy efficiency,** where people living in inefficient dwellings need to spend more energy to maintain thermal comfort, given the poor housing quality.

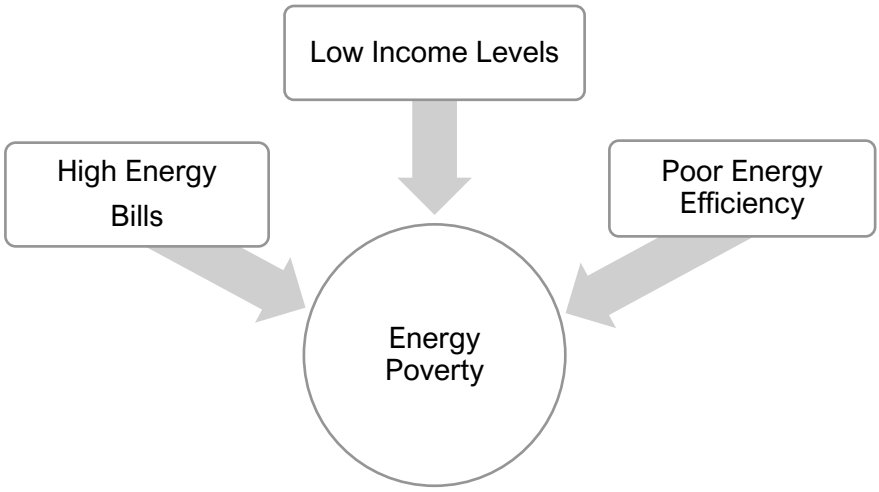

Figure 2 - Drivers of Energy Poverty

2.2 Energy Poverty in the EU: Policies, Regulations, and Leads

The European Commission recognized energy poverty as a significant challenge and conducted an introduction of requirements in energy legislation to better understand this multidimensional concept. The attention related to this concept seems to be growing, where regulations and policies are being applied to tackle EP. The first solid step within this field was the Energy Transition Framework and the Energy Union Strategy (COM/2015/080), settling down a basis for building an "Energy Union" that offers consumers, households, and businesses a secure, sustainable and affordable energy [35]. To achieve the goals set in the Paris Agreement and at the same time safeguard economic growth and job creation in a fair transition logic, in 2019, the EU introduced an energy policy framework called "Clean Energy for All Europeans Package". The proposals outlined in the framework had the following main objectives [33], [35]:

- **Prioritize** energy efficiency;
- **Achieve** world leadership in energy from renewable sources;
- **Establish** a level playing field for consumers, and cover energy efficiency, renewable energy, electricity market design, security of electricity, security of supply, and the governance standards of the Energy and Climate Action Union.

The Governance Regulation (2018/1999) of the European Parliament and the Council (11 December 2018) on Energy Union Governance and Climate Action, sets out in Article 3 Point 3. D) that the Member States in their National Energy and Climate Plans shall "assess 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" together with national plans with proper objectives to reduce energy poverty [36]. Energy poverty is also mentioned in the Energy Performance in Buildings Directive (2018/844), which stipulates that the Member State should cover and provide a clear overview of policies and actions targeting the segments with the worst-performing sectors of the national building stock. Furthermore, Member States should also outline national actions to promote equal access to financing for energy-poor consumers, social housing, and households subject to split-incentive dilemmas, taking into attention affordability [37]. The Directive 2009/72/EC states that "Member States shall take appropriate measures to protect final customers and shall ensure that there are adequate safeguards to protect vulnerable customers. Each Member State shall define the concept of vulnerable customers, which may refer to Energy Poverty…" [38]. Also, point 8 of the present Directive states that "Member States shall take appropriate measures, such as formulating national energy action plans, providing benefits in social security systems to ensure the necessary electricity supply to vulnerable customers, or providing for support for energy efficiency improvements, to address Energy Poverty where identified, including in the broader context of poverty" [38]. This expresses the

need for the Member States to consider appropriate metrics in the development of National Action Plans and criteria to tackle energy poverty, together with integrated national energy and climate progress reports.

Recently, the European Commission issued a specific recommendation on energy poverty, the Commission Recommendation (EU) 2020/1563. Given that this recommendation is an important element in the EU Strategy to tackle energy poverty, it is essential to mention the aspects described in this document in this 'literature' review. According to the present recommendation [2], the European Commission recommends that each member state must "Develop a systematic approach to the liberalization of energy markets, to share the benefits with all sections of society, particularly those most in need". Furthermore, on this recommendation, EC endorses that each Member State should develop measures to address energy poverty under close cooperation between all levels of administration, enabling intimate collaboration between regional and local authorities and civil society and private sector entities on this matter. In 2021, the European Commission issued a Proposal for the Energy Efficiency Directive Recast, laying down some more specific measures in which they consider that energy efficiency has been identified as the most effective solution to alleviate energy poverty. In line with the Renovation Wave Strategy, the Union funding support to energy efficiency and buildings renovation will help prevent EP, where the levels across the Member States will be in the spotlight as more Europeans may struggle to afford access to essential energy, particularly with rising energy costs and unemployment due to the covid-19 crisis [24].

2.2.1 Energy Poverty Advisory Hub & Energy Poverty Observatory

Being recognized by the research community as one of the most important players and one of the main leads providing expertise in an accessible approach for policymakers and civil society, the EPAH - Energy Poverty Advisory Hub, formerly EU Energy Poverty Observatory – EPOV, which was a 40-month project that commenced in December 2016, describes itself as the" leading EU initiative aiming to eradicate Energy Poverty and accelerate the just energy transition of European local governments" [40]. EPAH's mission also aims to be the central platform for local representatives and stakeholders interested in tackling energy poverty by providing research results and local action initiatives in a collaborative approach to combat energy poverty in the EU. Recently, in 2021, it was launched the Online EPAH Atlas, which is a great way to gain knowledge via many case studies and local measures adopted around the Member States. The report "Tackling Energy Poverty through local actions – Inspiring cases from across Europe" [26], released in late 2021, also contains a good selection of inspirational cases on EP mitigation measures and how energy poverty can be alleviated at a local level. In early 2022 the EPAH launched an introductory online course entitled "Introduction to energy poverty and the EPAH", which is a short course open to all stakeholders interested in tackling energy poverty by providing an overview of EP in a practical approach. The online course, available in 21 languages, aims to eradicate energy poverty and accelerate the just energy transition of European local governments. Still seeking to have a wider reach around Europe,

EPAH issued a call for technical support, which invited local governments and organisations to submit their request for technical assistance to receive some expert help in the process of tackling energy poverty.

EPAH was built on the EU Energy Poverty Observatory (EPOV) legacy, which was also an initiative by the European Commission to help the Member States how to tackle energy poverty by measuring and monitoring evils related to this issue, and so, establish energy policy at the EU level. Under the 40-month project, was published a methodology guidebook on EPOV's Indicator Dashboard [41]. The strategy followed by EPOV to select energy poverty indicators was based on an assessment of pertinent literature related to the measurement of this multidimensional concept. According to the guidebook, EPOV's intention was not to finally define energy poverty but to pick indicators that can be useful to view EP problems, which can later be explored in more detail to take local action. The outcome was the elaboration of the EPOV's Member State Report (2019), which summarized the key aspects of the energy poverty situation in each Member State based on indicators, policies, and publications gathered by the initiative.

The primary task of EPOV was to engender transformational change in comprehension of the magnitude of energy poverty in Europe and propose innovative policies and practices to combat it. Summing up, both EPAH and EPOV objectives have been [42]:

- **Improving transparency** by producing concrete statistics and analysis on the number of energy-poor households across the EU, and so outline the variable levels related to this concept;
- **Disseminating information and outreach activities**, serving as a hub for energy poverty by providing a user-friendly and open-access resource to promote public engagement as well as knowledge sharing to the EU-level decision-makers and appropriate stakeholders;

- **Providing technical assistance** to the widest possible range of interested parties positively impacts those concerned with fighting energy poverty.

2.2.2 EU Covenant of Mayors for Climate & Energy

Launched in 2008, the EU Covenant of Mayors (CoM) for Climate & Energy brings together thousands of local governments voluntarily committed to implementing EU climate and energy objectives [43]. CoM combines bottom-up governance, multi-level cooperation, and a context-driven framework to provide access to secure and affordable energy to all citizens by tackling energy poverty as one key action to guarantee a just transition. To reach these goals, the Covenant of Mayors teamed up with EPAH in one of its Work Packages (WP), whose major objective was to enhance the quality of life and create a more just and inclusive society. Align with these objectives, CoM launched the "Alleviating Energy Poverty: Useful Resources" publication as part of the awareness-raising process where information about energy poverty

monitoring tools, guidance materials, recommendations on how to involve citizens in energy poverty projects, and policy materials can be found [44]. As part of the Covenant of Mayors movement, signatories (municipalities) are committing to tackle energy poverty to ensure a just energy transition.

Recently, in May 2022, in order to assist with the planning and implementation of efforts on energy poverty, the CoM launched the energy poverty Pillar. The development of support indicators for diagnosis was done in cooperation with the European Commission's Joint Research Centre (JRC) and the EU Energy Poverty Advisory Hub (EPAH). In essence, municipalities that join the Covenant of Mayors commit themselves to making efforts to mitigate the problem of energy poverty [45]. The Covenant of Mayors provides support and guidance to municipalities to implement their actions through the Pillar, which is a framework of indicators for municipalities to get insights on how to perform energy poverty assessments and monitoring in their regions [45], [46].

2.3 Energy Poverty Indicators: Key-Publications and Methodological Approaches

As mentioned earlier in this chapter, a uniform definition of energy poverty has not yet been established at the European Union level. Due to the lack of a specific definition and given that a single indicator cannot capture energy Poverty, several indicators and indexes have been developed in the last years to assess this multidimensional concept [47], each with its merit in evaluating the problem's extent. Such indicators can be useful to provide some insights by contributing to a systematic assessment of energy poverty in the European Union. In addition to the exploration of the most important EU Policies and Regulations/Directives on energy poverty, this chapter aims to review these indicators and propose the ones that are more used by policymakers, the research community, and civil society to better understand the problem, which can then be used to develop target policies.

In their overview on the measurement of energy poverty in Europe, Thomson et al. [21] concluded that are several different approaches to define and measure it. Still, all these approaches can be related to three main methods of measurement:

1. **Expenditure-based** – where examinations of the energy costs faced by households against absolute or relative thresholds provide a proxy for estimating the extent of domestic energy deprivation;
2. **Consensual Approach** – based on self-reported assessments of indoor housing conditions and the ability to attain certain necessities relative to the society in which a household resides;
3. **Direct Measurement** – where the level of energy services (such as heating) achieved in the home is compared to a set standard.

Further on, a theoretical framework of metrics will be introduced and developed by some of the best-known organizations providing expertise and knowledge in an open-access way on

energy poverty [20]. Given the scope of the present work (EU Island Regions), it is important to explore some methodological approaches for measuring energy poverty in similar regions.

Following the information above, in their article named "The policy implications of energy poverty indicators" [48], Romero et al. provided a selection of energy poverty studies around Europe, presenting a great variability of energy poverty indicators that can be used to address this phenomenon. Both in the article about the Canary Islands [49] and the one about policy implications of energy poverty indicators [48] the authors seem to agree that the most widely used income-based energy poverty indicators are:

- **10% Indicator:** where households are considered to be energy poor if their expenditure on energy is not below 10% of their annual income [48], [49].
- **Double Median Expenditure (2M) Indicator:** where energy-poor households are those whose energy expenditure is higher than or equal to double the median share of the household's energy expenditure [49].
- **Low-Income/High-Cost Indicator:** where energy-poor households are those whose income is below a certain poverty threshold and when their energy costs are higher when compared to an energy expenditure threshold [48], [49]
- **After Fuel Cost Poverty:** where an energy-poor household is said to be in an energy poverty condition if its net income is lower than 60% of all household's net income median [49].
- **Minimum Income Standard (MIS):** where a household is energy poor if its net income (after deducting energy expenditure and housing costs) is lower than the social insertion basic income or the minimum income allowance [48], [49].

Siksnelyte-Butkiene et al. [50] provided a systematic review of indicators for measuring energy poverty, where a total of 71 indicators were identified. In this paper, was carried out a literature review regarding the application area as well as the case study location in which the following indicators were used: 10% indicator; Double Median Expenditure Indicator (2M); Minimum Income Standard Indicator (MIS); Low Income High Cost (LIHC); After Fuel-Cost Poverty Indicator (AFCP), between others regarding EU-SILC indicators**.**

Among the literature, there is a case-study about indicators for comparing energy poverty between the Canary Islands and Spain. In the "Improving Indicators for Comparing Energy Poverty in the Canary Islands and Spain" [49] article, Aguilar et al. propose a methodological approach for measuring and comparing energy poverty between the Canary Islands and Spain. In this study, the authors explore some ways to measure energy poverty present in the whole literature. Firstly, they split the measurement of EP into two different groups: income-based indicators and non-income-expenditure-based indicators. According to them, the first one belongs to an objective and quantitively methodology (often used in Europe).

In contrast, the second one refers to direct observation of this multidimensional concept through surveys about household living conditions. They seem to agree with Heindl´s [51]

classification of energy poverty indicators, where it´s explicit that all these indicators should be considered when studying the energy poverty condition of a given country.

Regarding assessing energy poverty vulnerability, it is necessary to have a joint effort among the scientific community and governments to assess this type of condition at different spatial scales. Only in this way will it be possible to measure the different contexts towards the formulation of tailored policies that identify all vulnerable consumers, avoiding discrimination [52]. In this way and concerning the energy poverty associated research at different subnational scales, Palma and Gouveia [52] reviewed energy poverty studies developed to target and identify the energy-poor population at spatial scales smaller than the national one. As referred to in the report, it is possible to collect helpful knowledge to support local initiatives through the review of EP assessments at greater spatial resolution scales for specific contexts and territories.

In the report "Bringing Energy Poverty Research into local practice - Exploring Subnational Scale Analyses" by presenting a review of energy poverty measurements at subnational spatial scales, Palma and Gouveia [48] examined three different pools of EU countries: Central and Eastern Europe, Western and Northern Europe, and Southern Europe. Regarding the pool covering Southern Europe countries, 29 different studies were reviewed. Among these studies, in Portugal, Gouveia et al. [4] developed an energy poverty vulnerability index, which is a high-resolution scale composite index focusing on space heating and cooling. The method was then tested on the 3092 civil parishes of Portugal to map energy-poor regions and identify potential hotspots for local action. Still on the Southern European pool, in Greece, Papada et al. [53] developed a "Stochastic Model of Energy Poverty" whereby firstly modeling energy consumption at the household level was developed a method to make the transition from household level to country level through stochastic analysis. In the Western & Northern Europe Pool, where 17 studies were reviewed, in France, Stojilovska et al. [54] compiled a qualitative study exploring the existence of energy-poor households in four European Countries:

Austria, North Macedonia, France, and Spain. In North Ireland, Walker et al. [55], using various environmental and socio-economic variables, developed a small area fuel poverty risk index for Northern Ireland via the computational tool Geographic Information System (GIS). Lastly, on the Central and Eastern Europe Pool, a number of 6 different studies were examined where, in Poland, Frankowski et al. [56] explored topics such as air quality and smog alerts by exploring the role of smog alerts in resolving energy poverty issues.

Recently, Vourdoubas et al. [57] developed a study to assess the energy poverty condition in the Greek Island of Crete during the Era of Economic Crisis (2007-2018). In this regional-specific concentrated work, through an analysis of the consumption of electricity and heating oil together with GDP changes in the country, they found a direct relation between the severe economic crisis and the increasing of energy-poor households in Crete. For this period, in Greece, the reduction of the GDP per capita in current $ was -29.5%, where both electricity and heating oil consumption in the island of Crete was also reduced by 25.98%.

2.3.1 Trinomics: Selecting Indicators to Measure Energy Poverty

This report is one of the most important references for this work. The Trinomics report on "Selecting Indicators to Measure Energy Poverty" [24], which was an effort under the pilot project to assess the impact of the energy poverty crisis, provides an extensive review of metrics to explore the effects of energy poverty as well as a deep conceptual map that can be useful to monitor this phenomenon by choosing a set of proper indicators to capture the economic, social and technical aspects of the circumstance.

The Trinomics report provides a wide-ranging analysis of energy poverty indicators, which is present in Annex A. According to their publication, 178 indicators were referred to in the pertinent literature, and the main official reports were assessed. Similar to what was presented earlier in this chapter, Trinomics identified two main approaches to define energy poverty metrics in which the indicators seem to fall: expenditure-based and consensual-based. In accordance with the report, of the 178 indicators that were assessed, 58 were related to expenditure, while 51 were based on physical infrastructure. Moreover, in this key publication, a recommended general approach to select indicators to measure energy poverty can be reached. For this purpose, Trinomics considers an upside-down pyramid with the following seven stages to select metrics at a Member State level:

1. Define the concept of energy poverty and its impacts.
2. Define approaches to measure energy poverty.
3. Define how each approach should be ideally implemented.
4. Define supporting indicators based on a conceptual map.
5. Cross-check with top-scoring indicators based on indicator assessment.
6. Consult with experts.
7. Select indicator set for testing.

In the last chapter, the report explores the development of a roadmap tool to measure and monitor energy poverty. To produce a concise tool, several publications were reviewed in this part. The roadmap includes four different main stages: development, test, implementation, and monitorization. Some clear recommendations are available in the report. One of them refers to improving datasets at the European level to improve the measurement of energy poverty. Thus, Trinomics clarifies that by including a variable in the EU-SILC survey that refers to energy spending, it would be possible to measure all energy poverty metrics based on this survey's methodology.

2.3.2 EPOV Indicator Dashboard: Methodology Guidebook

EPOV was one of the most important initiatives related to energy poverty at the European level, providing knowledge in an accessible and open-approach way for EU-level decision-makers and appropriate stakeholders. Under the 40-month project was published a methodology guidebook on EPOV's Indicator Dashboard [41], where it´s present an approach to measure energy poverty. This approach combines several indicators referred to in the pertinent literature, which can then be observed and used in combination to capture EP, given that each indicator captures a distinctive aspect of the phenomenon. Both on the EU Energy Poverty Advisory Hub (former EPOV) online platform or in the EPOV Methodology Guidebook, there is a metric divided into primary and secondary indicators.

2.3.2.1 Primary Indicators

EPOV gives four distinctive essential/primary indicators that can be used to capture energy poverty. According to Table 2, two of them are linked to self-reported situations related to lack of access to adequate levels of energy, based on EU-SILC [1] target datasets. The other two are calculated by exploring energy expenditure data from HBS [2] datasets.

Table 2 - EPOV Methodology Guidebook: Primary Indicators [30]

Indicator	Type	Description	Source
Arrears on Utility Bills	Consensual-based	Format of the 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?"	EU-SILC
Inability to Keep Home Adequately Warm	Consensual-based	Format of the question: "Can your household afford to keep its home adequately warm?"	EU-SILC
Low Absolute Energy Expenditure (M/2)	Expenditure-based	Share of households whose absolute energy expenditure is below half the national median.	HBS
High Share of Energy Expenditure in Income (2M)	Expenditure-based	The 2M indicator presents the proportion of households whose share of energy expenditure in income is more than twice the national median share.	HBS

[1] **EU-SILC:** EU Statistics on Income and Living Conditions (EU-SILC) produced by Eurostat, which collects data on income, poverty, living conditions, and social exclusion. [2] **HBS:** Household Budget Surveys (HBS) that are national surveys focusing mainly on household expenditure on goods and services, conducted in each Member State.

2.3.2.2 Secondary Indicators

Additionally to the primary indicators, EPOV compiles a range of 19 secondary indicators based on European Datasets: EU-SILC, which are statistics produced by Eurostat that collect data on income and living conditions, and EU Building Stock Observatory (BSO), which contains a database for monitoring the energy performance of buildings across Europe by covering a range of energy-related topics such as information on the building stock, energy consumption, building elements, and energy poverty. Such indicators are not directly related to energy poverty itself but can provide and gather an overview in the context of EP. EPOV splits the indicators, which are presented in Annex B, into five distinctive areas:

- **Energy Prices** with an overview of the average household prices related to energy systems (fuel, biomass, coal, electricity, and district heating);
- **Consensual-based** centered on self-reported population assessments of indoor housing conditions (dwelling comfortably cool/warm during summer/winter time and presence of leak, damp or rot in their dwelling);
- **Expenditure-based** through analyses of the consumption expenditure related to energy costs faced by households;
- **Building Stock Features/Elements**;
- **Poverty and Health Risks** with data on the poverty and social exclusion rates and health consequences which may be useful to link with primary energy poverty data.

2.3.3 OpenExp: European Energy Poverty Index (EEPI)

OpenExp is an international network composed of independent experts who focus on finding solutions to support Sustainable Development Goals across the world. This entity works closely with policymakers, business leaders, civil society, and the scientific community. The primary mission is to provide knowledge through a collaborative approach that commits to open access, so the sharing of key resources is a maximum value [58].

The European Energy Poverty Index (EEPI), depicted in the OpenExp Report [59] launched in January 2019, is probably one of the recently best-known publications on this matter, which was assigned by the European Climate Foundation and targeted a wide range of actors interested in energy poverty involving officials at different levels of governance. Defined by OpenExp, the European Energy Poverty Index (EEPI) is a composite indicator that scores and represents Member States' progress in alleviating domestic and transport energy poverty. Thus, the EEPI aggregates two sub-indexes: the European Domestic Energy Poverty (EDEPI) sub-index and the European Transport Energy Poverty (ETEPI) sub-index. On both, the higher the score, the better the performance of a certain Member State [59]. Given the scope of the present work, it will only be addressed in this sub-chapter the European Domestic Energy Poverty (EDEPI) sub-index given that this index can be quite important later in the discussion of the obtained results as a method of comparison between different regions. The metrics considered

to elaborate this specific sub-index capture causes of domestic energy poverty described in the literature when designing indicators to measure EP. In Figure 3, are described insights into how four factors contribute to inclusive rates of energy poverty in each Member State:

- **Level of discomfort** in winter (inability to keep homes adequately warm);
- **Level of discomfort** in summer (inability to keep homes comfortably cool);
- **Quality of dwellings** regarding leaking roofs, damp walls, and rot in windows frames;
- **Share of energy expenditures** out of total expenditures.

Figure 3 - Contribution of each factor to domestic Energy Poverty by country. Source: [38]

By reviewing Figure 3, some very important key points can be obtained. While the 2019 EDEPI rank confirms that in Sweden (a country known for its extreme winter temperatures) winter and summer domestic energy poverty might not be so relevant, in Bulgaria, an important action is needed to alleviate both summer and winter energy poverty, where the share of energy expenditures together with the inability to keep home warm or cool reveal inefficient domestic energy services too. Furthermore, countries like Sweden and Finland have highly insulated dwellings, saving some expenditures on energy bills.

The Right to Energy Coalition (R2E), a network committed to ending energy poverty, adapted the distribution of energy poverty in the EU very well based on the OpenExp report. In their report on "Upholding the right to clean, affordable energy for all in the EU" [5], they compiled

in the form of a geographical map the OpenExp EDEPI score, reflecting some distinctive ranks across the different EU Member States. In Figure 4, a strong division in the geographical scores of energy poverty in the EU can be witnessed. This could be explained by the discrepancies at geographic levels, different climate characteristics, distinctive income levels, and variations in policy measures. The EDEPI score shows a clear divergence between Western/Northern countries and Eastern/Southern-Eastern countries on tackling EP. OpenExp also analyzes the different obtained scores. According to them, the top countries making progress in facing domestic energy poverty (Sweden, Finland, Denmark, Austria, Luxembourg, etc.) are also the Member States with a Gross Domestic Product (GDP) per capita higher than the EU average, which has long-term sustainability and building regulations as well as tailored policy to tackle energy poverty. Besides that, contrary to what might be expected, rates of EP are lower in North-Western regions (cold regions) compared to warmer regions. Making the connection between both figures, it can be observed that in South/South-Eastern regions and Baltic countries, the building stock is so inefficient that households experience discomfort in both winter and summer in parallel with the fact that they have high energy expenditures all year.

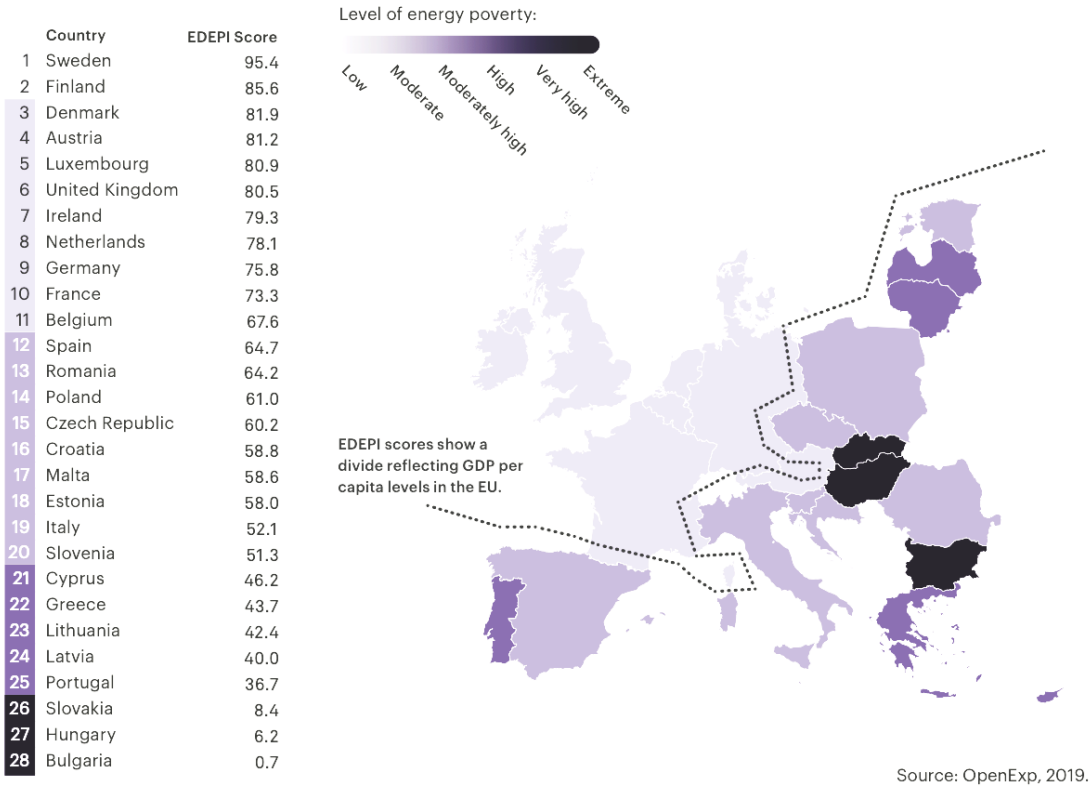

Figure 4 - OpenExp EDEPI distribution scores, by country. Sources: [5], [38]

2.4 Key-Sources of Data

Although they are not an organization exclusively concerned with energy poverty, European Union Statistics from Eurostat has been a reliable data source for EP assessments. It's common to see research projects/initiatives using Eurostat's Datasets to perform and make conclusions about the status of EP. For this specific work, the most important "databases" for the development of an analysis and assessment of energy poverty were the following ones:

- **EU Statistics on Income and Living Conditions (EU-SILC)** aims to collect comparable cross-sectional and longitudinal data on income, poverty, social exclusion, and living conditions. Launched in 2003, EU-SILC-based data aims to provide quantitative evidence for examining the accomplishment of social inclusion dimension of the European Pillar of Social Rights [60].
- **Household Budget Survey (HBS)** – National surveys across the Member States that mainly focus on household expenditure related to goods and services. It is used to compile weightings for important macroeconomic indicators [61].
- **EU Labour Force Survey (EU-LFS)** – Largest household sample survey which aims to classify the population on labour participation age (15 years and over) into three distinct factions: employed population, unemployed population, and the population outside the labour force [62].

EPAH, Trinomics, and OpenEXP, which have been essential players providing expertise in a collaborative and open-access approach for policymakers, civil society, and the scientific community, often use Eurostat Datasets in their metrics and methodologies to analyze energy poverty. From here, without Eurostat databases, it would be much harder to estimate the scale of the problem and the proportion of the European population threatened by this complex phenomenon.

3

METHODOLOGY

The present chapter presents four main sections. The first one will provide an overview of the definition of the research target by exploring some important steps that helped create the broadest possible data disaggregation to finally define the regions considered for the assessment of energy poverty vulnerability. The second one explores the procedure to select energy poverty indicators that may express the existence of energy poverty in the considered NUTS2 regions. The third section briefly describes the data extraction process, where the primary data sources are consulted, and the processes to fight the lack of data are highlighted. The last section covers the description about the three types of analysis that were conducted where it's presented. Considering all the procedures described throughout this chapter, an illustrative flowchart of the general methodology regarding the purpose of this study can be seen in Figure 5.

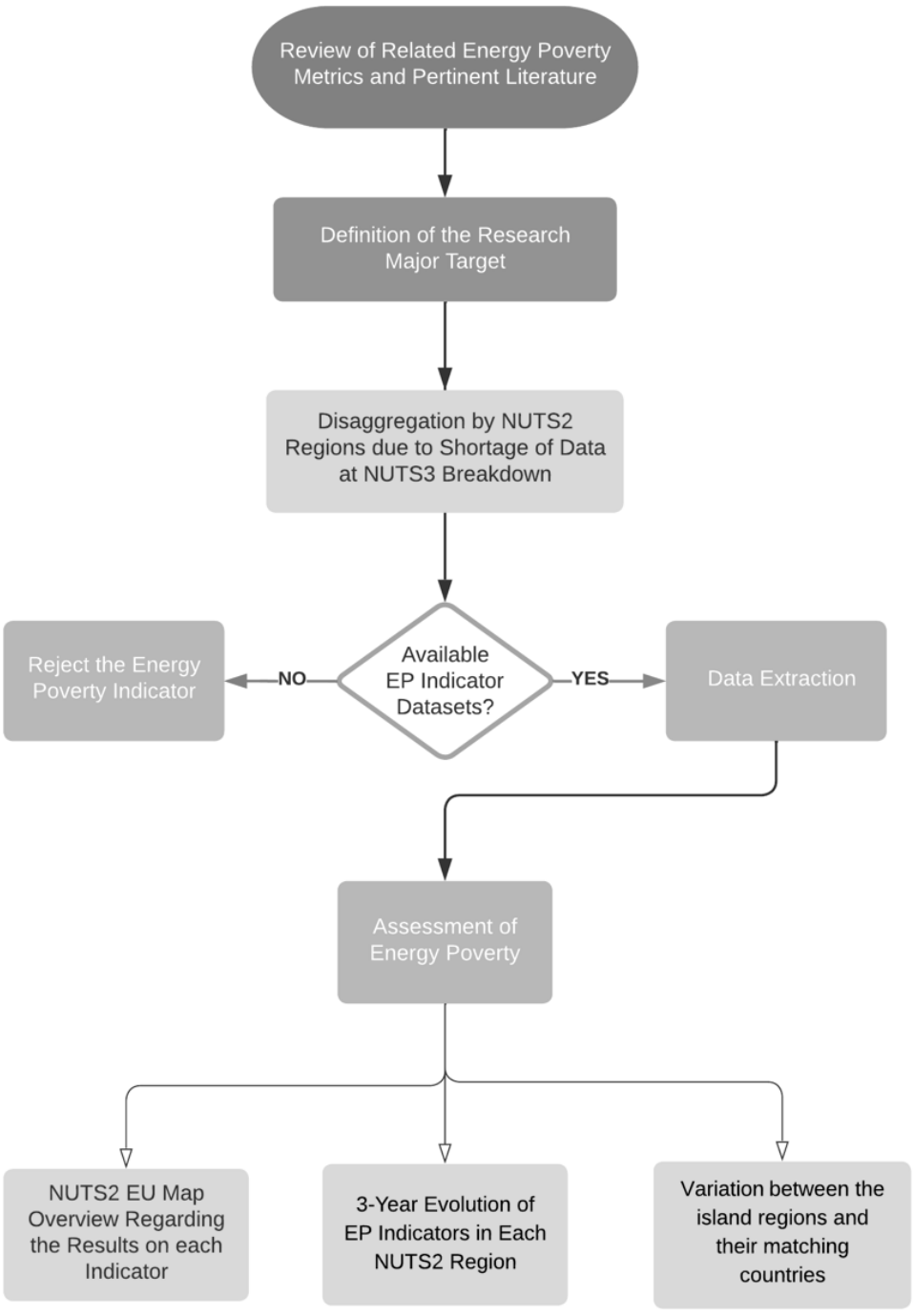

Figure 5 - Methodology Representative Flowchart

3.1 Research Scope and Procedure

In an early stage, the key objective was to project an energy poverty assessment with as much disaggregation as possible. As previously noted, Eurostat is the key database for this study as it contains energy poverty proxy indicators widely adopted by the scientific community. Therefore, the study will have to be performed following their statistical guidelines. On their statistical datasets, Eurostat uses the NUTS (Nomenclature of Territorial Units for Statistics) classification, which is a hierarchical system dividing the economic territory of the European Union to develop harmonization among the European regional statistics. They subdivide this classification system into three regions [63]:

- **NUTS1:** major socio-economic regions;
- **NUTS2:** basic regions for the application of regional policies;
- **NUTS3:** small regions for specific diagnoses;

Having in mind the major target of research (EU Islands), to have the widest possible disaggregation, NUTS3 Regions grouped by Island Typology had to be considered. For this task, was considered the 2021 NUTS Eurostat file [64] that presents a list of island regions of the European Union (EU-27) or the United Kingdom (UK) at the NUTS3 level. From this file, it can be concluded that there are 73 NUTS3 regions in EU-27 and UK.

However, the search for energy poverty indicator datasets disaggregated by NUTS3 revealed a shortage of data at this breakdown level. Thus, an alternative approach had to be considered. Hence, the search was set up with a breakdown of NUTS2 Regions, grouped by Island typology too. To continue with the broadest possible level of disaggregation of all the NUTS3 regions considered previously, the corresponding NUTS2 was retrieved. From here, a peculiar feature of the strategy adopted arises, where certain region differences might exist, as NUTS2 covers territories that address more regions in some Member States than others. In other words, some NUTS2 may relate to a single Island, others to a group of islands (archipelago) forming autonomous regions, and others may refer to countries. To be more explicit, bringing this theoretical assumption into practice, for example, while the NUTS3 of Crete (which is a NUTS2) refers to several micro-regions – Irakleio, Lasithi, and Rethymni - within that same island, the NUTS3 of the Autonomous Region of Azores (NUTS2), correspond to the Autonomous Region of Azores too, that is a group of islands. Shortening the example mentioned above, when looking into NUTS2 regions, there are different regions that can be studied depending on the Member State: one concerning only one Island and another concerning an autonomous region (archipelago) composed of several islands. There are also cases where NUTS2 regions are relative to a country, such as Malta and Cyprus. Finally, from the 73 NUTS Level 3 regions, grouped by Island Typology, 26 corresponding NUTS Level 2 were obtained, which can be found in Table 3.

Table 3 - NUTS Level 2 Regions by Island Typology

#	EU27/UK	Code	Country code	NUTS Level 2 Region (Island Typology)	English Designation
1	EU27	CY	CY	Cypros	Cyprus
2	EU27	DK01	DK	Hovedstaden	Hovedstaden
3	EU27	EL41	EL	Βόρειο Αιγαίο	North Aegean Region
4	EU27	EL42	EL	Νότιο Αιγαίο	Southern Aegean Region
5	EU27	EL43	EL	Crete	Crete
6	EU27	EL62	EL	Ιόνια Νησιά	Ionian Islands
7	EU27	ES53	ES	Ilhas Baleares	Balearic Islands
8	EU27	ES70	ES	Canarias	Canary Islands
9	EU27	FI2	FI	Åland	Åland Islands
10	EU27	FRM0	FR	Corse	Corsica
11	EU27	FRY1	FR	Guadeloupe	Guadeloupe
12	EU27	FRY2	FR	Martinique	Martinique
13	EU27	FRY4	FR	La Réunion	La Réunion
14	EU27	FRY5	FR	Mayotte	Mayotte
15	EU27	IE04	IE	Northern and Western	Northern and Western
16	EU27	IE05	IE	Southern	Southern
17	EU27	IE06	IE	Eastern and Midland	Eastern and Midland
18	EU27	ITG1	IT	Sicilia	Sicily
19	EU27	ITG2	IT	Sardegna	Sardinia
20	EU27	MT00	MT	Malta	Malta
21	EU27	PT20	PT	Açores	Azores
22	EU27	PT30	PT	Madeira	Madeira
23	EU27	SE21	SE	Småland med öarna	Småland and the islands
24	UK	UKJ3	UK	Hampshire and Isle of Wight	Hampshire and Isle of Wight
25	UK	UKM6	UK	Highlands and Islands	Highlands and Islands
26	UK	UKN0	UK	Northern Ireland	Northern Ireland

It is important to note that the regions Guadeloupe, Martinique, La Réunion, and Mayotte were not considered for data extraction since they belong to a Member State of the European Union (France). Still, they are not necessarily on European territory. The lack of data for such territories also showed up. The United Kingdom regions were also not considered, given the absence of data. In a nutshell, by excluding the French and UK territories mentioned above, 19 NUTS Level 2 Regions were achieved. It is also important to mention that although Corse has limited data available, it was not excluded from our study. These regions were the final regions to be considered for the assessment of energy poverty, given the main goal of the present study. The study regions obtained after all the methodological processes were adopted can be reviewed in Figure 6, obtained through the QGIS geographic computing tool.

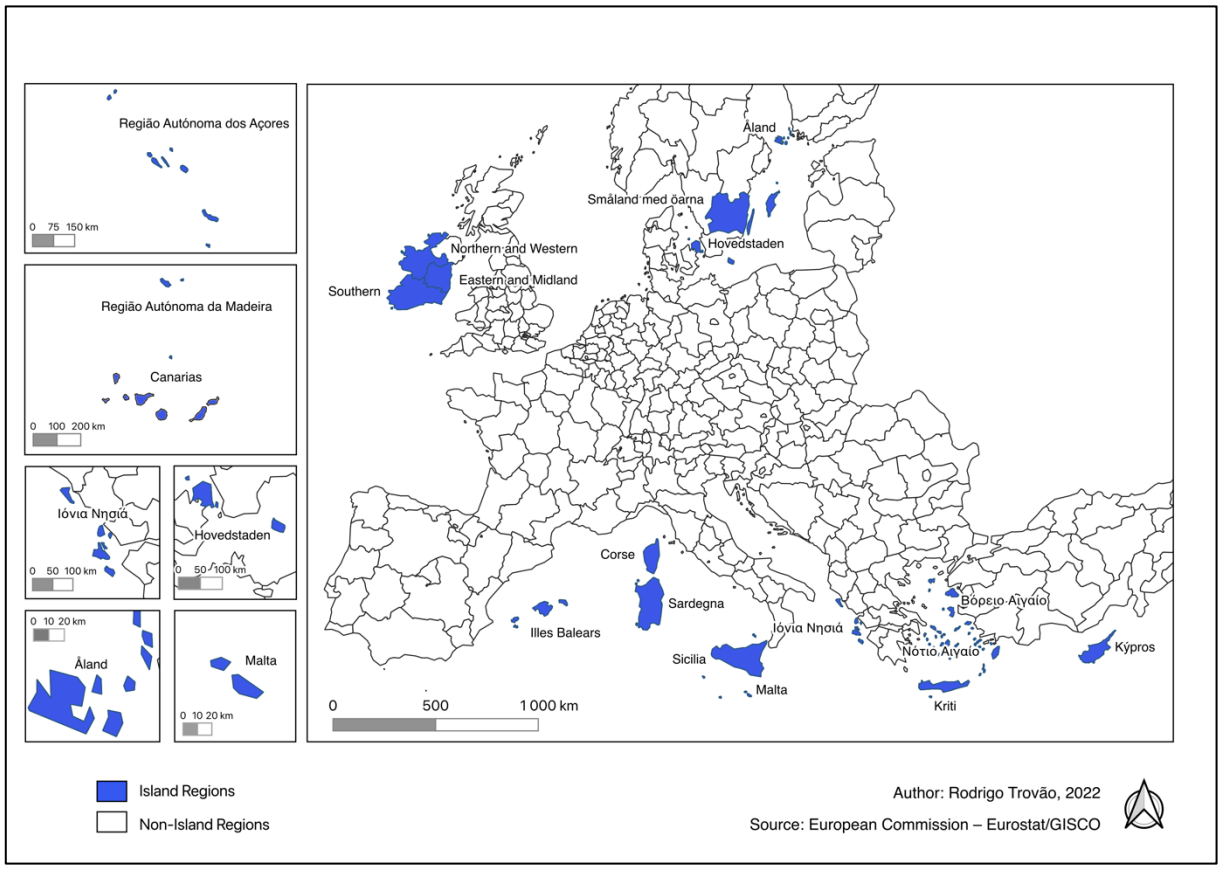

Figure 6 - NUTS Level 2 Regions by Island Typology (NUTS2 2021)

3.2 Selected Energy Poverty Indicators

Having defined the scope and methodology of the study, the step to evaluate energy poverty indicators in the NUTS2 regions (grouped by Island Typology) was undertaken. The initial intention was to try to include as many indicators as possible. Regarding this objective, several publications (referred to in Chapter 2) were reviewed to understand what kind of methodologies and indicators should be chosen to measure and monitor energy poverty. After carefully reviewing these publications, the existence of data for energy poverty indicators was investigated by following the disaggregation level referred to previously in the research procedure. It was possible to obtain a set of thirteen (13) indicators that may express the existence of energy poverty for the NUTS2 regions listed in Table 4. Of the thirteen indicators, 9 indicators are based on EU-SILC data, whereas the rest are either based on Eurostat Energy Statistics or in the Labour Force Survey (EU-LFS). There is also one socio-economic indicator belonging to the European System of National and Regional Accounts (ESA 2010). It should be noted that, as part of the research procedure, it was crucial to consult Eurostat, who in return transmitted that there are no EU-SILC datasets containing NUTS3 breakdowns.

Table 4 - Selected EP Indicators

#	Related Energy Poverty Indicators	Source	Type	ESTAT Code
1	People at risk of poverty or social exclusion by NUTS regions	EU-SILC	Socio-Economic	ilc_peps11
2	People living in households with very low work intensity by NUTS regions (population aged 0 to 59 years) - Percentage of total population aged less than 60	EU-SILC	Socio-Economic	ilc_lvhl21
3	Severe material deprivation rate by NUTS regions	EU-SILC	Socio-Economic	ilc_mddd21
4	At-risk-of-poverty rate by NUTS regions	EU-SILC	Socio-Economic	ilc_li41
5	At-risk-of-poverty rate before social transfers (pensions excluded from social transfers) by NUTS 2 regions	EU-SILC	Socio-Economic	ilc_li10_r
6	Income quintile share ratio S80/S20 by NUTS 2 regions	EU-SILC	Socio-Economic	ilc_di11_r
7	Income of households by NUTS 2 regions	ESA 2010	Socio-Economic	nama_10r_2hhinc
8	Material and social deprivation rate by NUTS regions	EU-SILC	Socio-Economic	ilc_mdsd08
9	Average number of rooms per person by NUTS region	EU-SILC	Socio-Economic	ilc_lvho04n
10	Self-reported unmet needs for medical examination by NUTS regions	EU-SILC (Health)	Socio-Economic	hlth_silc_08_r
11	Cooling degree days by NUTS 3 regions - annual data	ESTAT - Energy Statistics	Climate	nrg_chddr2_a
12	Heating degree days by NUTS 3 regions - annual data	ESTAT - Energy Statistics	Climate	nrg_chddr2_a
13	Unemployment rate by NUTS 2 regions	EU-LFS	Socio-Economic	tgs00010

3.2.1 Selected Energy Poverty Indicators Definitions

3.2.1.1 People at Risk of Poverty or Social Exclusion

According to Eurostat, the dataset 'People at Risk of Poverty or Social Exclusion' is part of the collection Living Conditions, which hosts the main indicators on the risk of poverty or social inclusion. This indicator represents a combination of three datasets – the at-risk-of-poverty rate, the rate of severe material deprivation, and the rate of very low work intensity [60]. Risk of Poverty or Social Exclusion represents a situation of vulnerability that is often associated with the incidence of energy poverty [59].

3.2.1.2 People Living in Households with very Low Work Intensity

Eurostat defines the indicator ´People Living in Households with very Low Work Intensity´ as the number of persons living in a household where the members worked a working time equal to or less than 20% of their total combined work-time potential during the previous year [65]. The household members are defined as the adult population aged 18-59 years old, excluding students between 18-24 years old. Furthermore, according to Eurostat, the work intensity of a given household is given as the ratio of the total number of months where all households belonging to the working-age and the total number of months where the same household members could have worked in the same period. The "Percentage of the total population aged less than 60" was chosen as the unit of measure for the present indicator.

3.2.1.3 Severe Material Deprivation Rate

As part of the EU-SILC dataset, ´Severe Material Deprivation Rate´ is an indicator that shows an enforced lack of necessary items to lead an acceptable life. Hence, following the Eurostat definition, the indicator provides an overview of the individuals who cannot afford a "certain good, service or social activities" [66]. The enforced lack is relative to 6 items at an individual level and 7 at the household level. On the individual level, there are present items like having an internet connection, replacing worn-out clothes with new ones, having regular leisure activities, having two pairs of properly fitting shoes, etc. Therefore, at the household level, the list of items respects the capacity to face unexpected expenses, the capacity to afford to pay for a one-week annual holiday, the ability to keep home adequately warm and access a car for personal use, replacing worn-out furniture, etc.

3.2.1.4 At-Risk-of-Poverty-Rate

Eurostat defines the ´At-Risk-of-Poverty-Rate´ indicator as the share of people where the equivalized disposable income, after social transfers, is below the at-risk of the poverty threshold. This threshold corresponds to a set of 60% of the national median relative to the equivalized disposable income after social transfers [67]. This indicator is not an absolute poverty or wealth measurement, but a relative measure of the inequality in the levels of income of a given country's population.

3.2.1.5 At-Risk-of-Poverty-Rate before Social Transfers

Eurostat defines the ´At-Risk-of-Poverty-Rate before Social Transfers´ indicator as to the share of people having a disposable income before social transfers that is below the "at-risk-of-poverty" threshold calculated after social transfers, where pensions are excluded from social transfers and counted as an income (before social transfers) [68]. Therefore, this specific indicator gives us a specific hypothetical overview of the non-existence of social transfers.

3.2.1.6 Income Quintile Share Ratio (S80/S20)

Eurostat defines the ´Income Quintile Share Ratio (S80/S20)´ as a parameter that measures the inequality of income distribution of a given population. S80/S20 compares the ratio of total income received by the 20% of the population with higher income (richest persons) to the ratio of total income received by the 20% of the population with the lowest income (poorest persons) [69].

3.2.1.7 Household Annual Income – Income of Households by NUTS2 Regions

To have a broader notion about income in the regions under study, in the Results Section, besides the indicator ´Income Quintile Share Ratio S80/S20´, the indicator 'Household Annual Income' was also explored in order to in order to reinforce the results with the variation between the NUTS2 regions and their corresponding matching countries average value regarding the annual income.

3.2.1.8 Material and Social Deprivation Rate

As part of the EU SILC – Material Deprivation collection, the indicator "Material and Social Deprivation Rate by NUTS regions" should also be considered when tackling energy poverty. This indicator "shows an enforced lack of necessary and desirable items to lead an adequate life", such as replacing worn-out clothes with some new ones, ability to keep home adequately, and capacity to be confronted with payment arrears [60].

3.2.1.9 Average Number of Rooms per Person

When looking at housing, the indicator ´Average Number of Rooms per Person´ could be very important to address living conditions. It is calculated by dividing the total number of rooms in a dwelling by the number of persons living there, which can indicate whether residents are living in crowded conditions or not. As referred to in the OECD better life index [70], which is an index that allows for comparing well-being across countries. Overcrowded housing may reveal a negative impact on physical and mental health, and children's development.

3.2.1.10 Self-Reported Unmet Needs for Medical Examination

According to Eurostat, the ´Self-Reported Unmet Needs for Medical Examination´ indicator concerns a given individual who needed a specific treatment or health examination but did not get it due to one of the following three reasons: financial purposes, waiting list, and travel too far [71]. For the present study on the NUT2 regions, it was considered only the reason "financial purposes" as a parameter of measure.

3.2.1.11 Cooling Degree Days

Cooling Degree Days (HDD) it is a weather-based technical index to describe the energy requirements of buildings in terms of cooling requirements that can contribute to the correct interpretation of trends in energy consumption for cooling in buildings. CDD reflects the amount of energy needed, for a given period, to cool the internal environment in a hot climate to a specified base temperature (24ºC) [7]. This indicator it´s also important to compare results between regions with other major socio-economic indicators.

3.2.1.12 Heating Degree Days

Heating Degree Days (HDD) it is a weather-based technical index to describe the energy requirements of buildings in terms of heating requirements that can contribute to the correct interpretation of trends in energy consumption for heating in buildings. The HDD indicator reflects the amount of energy needed, for a given period, to heat the internal environment in a cold climate to a specified base temperature (15 ºC) [7][42]. This indicator could be extremely important for analysing energy poverty when comparing the results with more specific indicators of the socio-economic needs of a certain population.

3.2.1.13 Unemployment Rate

Considered one of the most important economic indicators, the unemployment rate calculates the proportion of workers in the labor force who are actively seeking employment but do not yet have a job [73].

3.3 Data Extraction

Having the target regions and energy poverty indicators well defined, by extracting related data for each region, the assessment of EP in those regions began to be made. Initially, given the period in which this work/study is being performed, the goal would be to find the most recent data possible, specifically for the year 2021. After starting the data extraction process, it was noted that it would not be possible to obtain data as recent as had been anticipated. Given the period when the data extraction process started, at that time, only data for the year 2019 was available. Thus, data for 2020 was collected on a subsequent iteration, where the final check was made between May and June of 2022. After that, and to extend the data analysis period to a more significant time horizon, the data extraction process was extended to the years between 2018 and 2020. It is also important to mention that the whole data extraction process was conducted using the excel software tool.

3.3.1 Contact with Specialists in the Field

During the data extraction period, as time went by, it started to be noticed the inexistence of data regarding some energy poverty indicators for specific regions. The lack of data was characteristic of the following NUTS2 regions: Corse, Illes Balears, Canárias, Região Autónoma da Madeira, Região Autónoma dos Açores, Sicilia, and Sardegna. Given this situation, some secondary strategies had to be considered to combat the lack of data. These strategies include searching for data in the national databases of each member state (instead of only considering the Eurostat Database) and contacting experts in the field to find out where to look for the data. Regarding the last process, that is, contact with experts in the field, 11 different researchers from 4 different countries (France, Spain, Italy, and Portugal) were then contacted regarding the lack of data in the regions associated with their home countries. In general, during the contact process, concrete answers were provided with specific databases where the missing data could be found. After contacting Spanish researchers, which provided links to important databases/reports, it was possible to fill in some indicators about which it was not possible to extract information during the data extraction process. Specifically, some numbers were found for the indicators "Income quintile share ratio S80/S20" and "Self-reported unmet needs for medical examination" for the Balearic Islands and Canary Islands. Regarding the contact with portuguese researchers, after their clarification on where to find data on the "Income quintile share ratio S80/S20", it was possible to fill in the missing data for this indicator for the Azores and Madeira NUTS2 Regions.

3.4 Assessment of Energy Poverty Vulnerability

For the last step of the present work, i.e., the final assessment of energy poverty vulnerability across the different island regions, in Chapter 5 – Main Findings, three distinct types of analysis will be presented:

1. **EU Overview -** Using the QGIS computing software, considering the most recent data available (2020), maps will be made for each indicator. In this analysis, in each map, a colour scale will be included to classify each indicator at different levels, to obtain a general perspective at the European level. In this way, it will be possible to identify the main hotspots around the different regions for each indicator.

2. **3-Year Evolution of EP Indicators in Each NUTS2 Region -** Through excel, graphs will be drawn covering the data for each indicator with a time horizon of 3 years (2018-2020). In this way, it will be possible to make a more detailed comparison regarding the data for each region, being possible to detect the most significant differences and the evolution of each indicator over the past years, as well as the differences between regions. In addition, it will also be possible to explore some aspects that would go unnoticed if only the 2020 data regarding de EU map overview were considered.

3. **Comparison to the Matching Country Average Value -** By means of tables and with data from 2020, for each indicator, an analysis of results obtained between the island regions (NUTS 2) and their corresponding continental part (member state/country) will be made. This analysis will be done by calculating the results variation[1] between the island regions and their matching countries. The value of the associated countries concerns the average value of that same country on each one of the indicators that were investigated. Taking the results of each indicator, it will be possible to make a comparison between regions, detecting whether the levels of performance of each indicator are more or less severe in the islands than in their matching country average values.

In the end, an overall discussion will take place. This specific sub-chapter will be entirely dedicated to summarizing and exploring in detail some of the main findings and comparing them with some indexes highlighted in the literature review. In an attempt to analyse a potential relation between results, the following comparisons between different indicators will be made: Income & Unemployment vs. Poverty Rates, Climate vs. Material and Social Deprivation Rates, Deprivation Rate & Work-Intensity vs Unemployment, and Risk of Poverty vs. Material Deprivation Rates. Such interpretation of results may highlight the main causes for the existence of energy poverty vulnerability in certain regions. In fact, the relation of some indicators, like the socio-economic and climate ones, with major EP indicators could be essential to reveal an energy poverty vulnerability condition in a given region.

4

Energy Poverty Overview on the Related Member States

In this subchapter will be provided an overview of the Energy Poverty condition/status of the member states related to the NUTS2 regions that had been considered for the present study. Statistics related to energy poverty indicators produced by Eurostat, such as the inability to keep home adequately warm and the inability to pay utility bills on time will be presented for each member state, regarding the year of 2019. As explored previously, the EU Energy Poverty Observatory (EPOV), which is currently evolved into EPAH, was one of the main initiatives providing knowledge about the state of energy poverty in Europe. In February 2020, EPOV launched a report summarizing the key-aspects of the current energy poverty situation in each EU Member State, based on data gathered by Eurostat. The "Member State Reports on Energy Poverty" [74] provides an overview of the EP condition by exploring key-indicators, policies, and publications to better address this phenomenon in each member state. Thus, to better understand the energy poverty situation in each of the regions considered throughout the next chapters, this short and brief analysis for each related member state may be quite important.

4.1.1 Cyprus

In regard to energy poverty, Cyprus was one of the first member states to have an official definition for this phenomenon. According to the Eurostat statistics on Cyprus, in 2019, 21,0% of the population was unable to keep their home adequately warm. This number shows a minor performance when compared to the EU average, where the number in that same year was 6,7% [75]. The definition of Cyprus on energy poverty also defines that these vulnerable consumers are eligible to receive a specific reduced electricity tariff, financed through a general electricity fee on electricity prices. Besides some financial incentives given to the vulnerable consumers to install renewable sources for self-consumption like photovoltaic systems, there have been some public funding programs where the main objective is to help households to proceed with the renovation of their dwellings in order to improve energy efficiency [74].

4.1.2 Denmark

Denmark´s scenario on energy poverty it´s very different from the one of most of the EU countries. In fact, the percentage of people unable to keep home adequately warm in 2019 was only 2,8%, which is less when compared to the EU average (6,7%) [73]. From the EPOV member states report, where an overview of the energy poverty situation in Denmark was presented, it can concluded that there are some social financial instruments to help people under this situation, such as financial assistance from municipalities where households in a difficult socio-economic situation may apply. There are also some measures for improving the energy efficiency of housing, where some programs like "Better Housing" could support homeowners in the application of energy efficiency measures and assist them in renovating the houses from the very beginning [74].

4.1.3 Finland

Finland has a very specific EP condition. In regards to people being unable to keep home adequately warm (2019), Finland it´s one of the member states with the lowest value (1,8%) [75]. In fact, the EPOV report on Finland exploits very well a specific situation occurring in this member state. In the year 2019, 7,8% of the Finnish population was unable to pay utility bills on time [76]. When comparing this number to the percentage of the population unable to keep home adequately warm presented above, it can noticed a markable disconnection. This difference between such indicators can explain that an arrear on some payments does not specifically end with an end on the supply [74].

Related to the information presented above, Finland has some financial tools to control such conditions. As a matter of fact, their social support system includes a "basic income support" provided to the low-income households, where housing-related expenses like heating and electricity costs are covered. Besides that, the low-households have also some incentives to renovate their houses by increasing the efficiency of their buildings together with the implementation of renewable technologies [74].

4.1.4 France

In regards to energy poverty, France is one of the most active countries in assessing and tackling this specific condition. Similar to what has been discussed so far in this work, in 2019, 6,2% of the French population was unable to keep their home adequately warm while 5,6% of the population was incapable of paying their utility bills on time-related with financial difficulties. Such numbers are below the EU average where the numbers reveal to be 6,7% and 6,1%, respectively [75], [76]. Such results reveal that France has a higher performance on the population-related energy poverty indicators when compared to the EU average condition. With the aim to improve domestic energy efficiency, France has been implementing some measures to tackle EP over the past few years. Measures like the "Energy voucher" (2018), "Renovation Voucher" (2020), and the "Financial help regarding arrears on energy bills"

program, along with some important energy audit programs were fundamental to assess and coordinate actions to tackle EP trough a national level [74].

4.1.5 Greece

Parallel to what has been discussed so far, Greece's condition on energy poverty is quite severe, where the performance on the related population-reported indicators shows us a lower performance than the EU average. In 2019, 17,9% were unable to keep their home adequately warm, revealing a huge and lower difference from the EU average condition scenario. While 6,1% of the population at the EU level (average) was unable to pay their utility bills on time, in Greece, the number grew to 32,5%, which is notably higher [74],[75], [76].

Aiming to inform the policymakers about the EP Greece condition, a Greek Energy Poverty Observatory was settled down. Greece was under a huge financial crisis, which can explain some low-performance numbers on energy poverty-related indicators. Over the past few years, some measures to support vulnerable consumers have been implemented. Programs like the "Social Residential Tariff" have been implemented to support energy poor households. In fact, between late 2016 and early 2017, there was a program called "Heating Oil Allowance", which cover 380.000 beneficiaries (low-income households) with heating oil costs [74].

4.1.6 Ireland

While, in 2019, the number of people unable to keep home adequately warm was 4,9% (lower than the EU average), the number of people unable to pay their utility bills on time was 8,9% (higher than the EU average), revealing that Ireland has a mixed performance on EP when comparing to the countries at an EU level [75], [76]. Furthermore, EPOV member states report highlights that the indicator related to the utility bills it´s not 100% trustful when estimating the extent of EP in Ireland since most of the houses use oil and solid fuels for heating, which are paid up-front and not related to a utility bill [74].

Similarly to what has been presented so far to the other member states, there are multiple measures in Ireland that aim to tackle energy poverty. Parallel to the "Social Housing Retrofit Programme", which helps low-income households receive free energy efficiency upgrades on their houses, in Ireland, there are some fuel allowances responsible for helping these households with increasing heating costs across the colder months [74].

4.1.7 Italy

Numbers from 2019 show that 11,1% of the Italian population was unable to keep their homes adequately warm, which is almost two times higher than compared to EU average numbers. On the other side, Italy seems to have a higher performance than the EU average on the people unable to pay their utility bills on time, with only 4,5% of the population in this situation [75], [76].

At the end of 2019, Italy submitted a "National Energy and Climate Action Plan" to the EU Commission, with selected measures and targets specifically designed to tackle energy poverty. Existing policies like an electric and gas social bonus, tax deductions on electricity and heating fuel, tax deduction for the renovation of the low-energy efficiency buildings, and some intentions to promote a better knowledge of the Italian energy poverty situation by promoting assistance to stakeholders can be found in this Plan [74].

4.1.8 Malta

In 2019, 7,8%% of the population in Malta was unable to keep home adequately warm, while 6,5% of the population was incapable of paying their utility bills on time-related with financial difficulties [75], [76]. Such numbers are slightly lower when assessing the EU average condition, where the results are 6,7% and 6,1%, respectively. The share of households that spend a high share of their income on energy expenditure is 20.1% (EU average: 16,2%), which might represent a poor energy efficiency of the building stock.

In Malta, groups like low-income households, pensioners, unemployed persons, and disabled persons can benefit from the "Energy Benefit" program, which provides financial assistance to such groups in paying their electricity bills. There is also a support scheme for renewable energy and insulation that could help households improve building isolation, heating/cooling systems, and energy efficiency through financial assistance to invest in better options [74].

4.1.9 Portugal

In 2019, while 18,9% of the Portuguese population was unable to keep their homes adequately warm, only 4,3% was unable to pay their utility bills on time [75], [76]. The difference between such indicators could be related to the fact that a high share of the population steal uses rudimentary forms of heating. In fact, there is a high share of wood fuel used by the population for heating purposes, which is not included in the utility bills. Regarding energy poverty in Portugal, a slight increase in the research activity on this topic over the past few years can be noted, focusing mainly on the geographical extension of this phenomenon by developing multidimensional tools to assess the main hotspots [4]. There are also studies on the distribution of thermal comfort as well as the health impacts of poor housing conditions.

The social tariff is the main financial tool to tackle energy poverty, where low-income households can get financial assistance to pay their energy bills. Indeed, according to recent data, around 14% of Portuguese households benefit from this measure. Furthermore, there are also programs like the "Energy Efficiency Fund" [74] or the Recovery and Resilience Plan related funding for residential buildings renovation (e.g Edificios Mais Sustentáveis II), where the main target is to improve energy efficiency through the replacement of heating and cooling systems as well as improving building insulation or solar PV adoption.

4.1.10 Spain

In 2019, on the population-reported indicators, Spain's performance was right below the EU average, with 7,5% reporting that they were unable to keep their home adequately warm (EU average: 6,7%) and 6,5% reporting that they were unable to pay their utility bills on time (EU average: 6,1%) [75], [76].

To tackle this major problem, Spain has conducted several measures like the "Social bonus for electricity", where it´s provided energy bill support, the "Program for the promotion of building renovations" (2013), and the "Housing renovation program for vulnerable households" where the main target is to improve building isolation and heating/cooling systems, and finally the "Energy Advice Points" where households can get pieces of advice as well as information on energy savings and energy efficiency. The previous Social bonus for electricity was updated in 2017, where was also created a social bonus for heating, where vulnerable consumers can get energy bill support on heating, warm water, and cooking costs. Alongside all the measures presented above, there is also considerable research activity in Spain, with more than 20 related energy poverty organizations listed [74].

4.1.11 Sweden

Similar to Finland, Sweden's population-based report indicators seem to present a better performance when compared to the EU average situation. In fact, in the year of 2019, only 1,9% reported to be in a condition that they are unable to keep their home adequately warm, while 2,3% reported to be unable to pay their utility bills on time, revealing that energy poverty levels are relatively low in Sweden [75], [76]. EPOV member states report enhances that in Sweden, the energy poverty low levels are powerfully connected to the implementation of strong social policies which are responsible to keep the country in such conditions of EP. In fact, low-income households can get social support for their living costs, such as accommodation and electricity costs [74].

5

MAIN RESULTS AND FINDINGS

Results reveal a wide-ranging distinction across the EU Island Regions, reflecting the different distribution of energy poverty in Europe, which can be explained by the differences in geography, climate, income levels, and local-policy action. In this chapter, it will be made an analysis of the results obtained for each EP indicator across the NUTS level 2 regions that could be interesting to identify situations of energy poverty, finally making some comparisons between different indicators to back up some of the obtained results. Throughout the present chapter, the main findings regarding each energy poverty indicator will be studied in three different ways. Firstly, an EU Map Overview regarding the results on each indicator to the NUTS2 Regions will be reviewed, where a perspective at an EU level can be obtained. In second place, the results for each region with a three-year time horizon will be addressed to obtain a detailed comparison and notice significant changes (or not) over the past few years. Lastly, the variation of results between the NUTS2 regions and their associated countries will be calculated to detect whether the levels of performance regarding each indicator are more or less severe in the islands when compared to their matching country average values. By the end of this chapter, an overall discussion will take place, where the main purpose is to present the relation between the results regarding specific indicators that could further support the existence of an energy poverty vulnerability condition.

[1] **Variation:** calculated using the formula **(X-Y)/Y**, where X denotes the result regarding the selected indicator for each NUTS Level 2; Y denotes each country average value for the selected indicator.

5.1 People at Risk of Poverty or Social Exclusion

5.1.1 EU Overview

As it can be perceived through the map (Figure 7), where an EU overview of the indicator "People at Risk of Poverty or Social Exclusion" is provided, there are significant differences across the distinct territories for the year 2020. The main hotspots are the Southern-European regions (specifically the Italian islands) and the Canary Islands, where the numbers are: Sicilia (44,7%), Canary Islands (36,3%), and Sardegna (33,8%). Both the Portuguese regions (Azores and Madeira) and the North Aegean Region (Βόρειο Αιγαίο) reveal to be vulnerable to this indicator as well. The regions with the lowest rates of poverty or social exclusion are: Hovedstaden (17,3%), Småland med öarna (17,3%), and Eastern and Midland (17,2%).

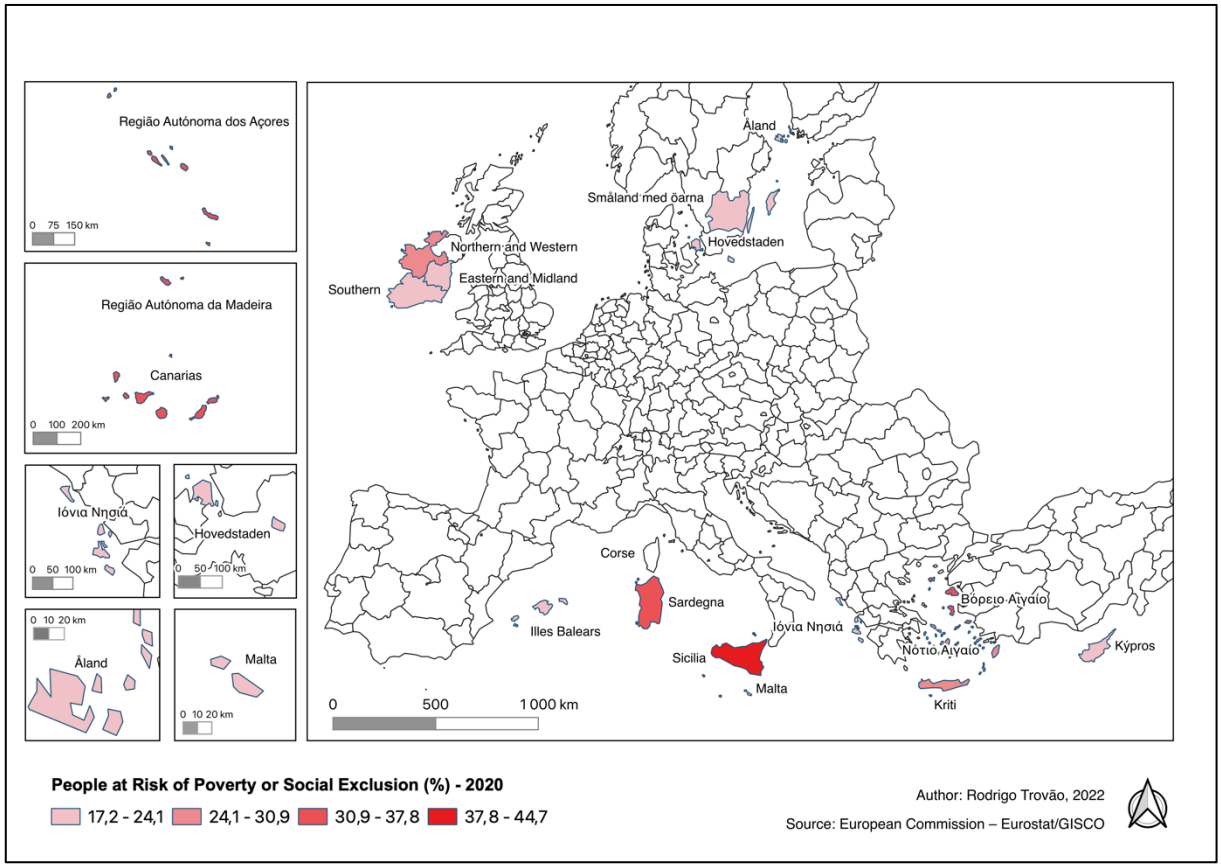

Figure 7 - People at Risk of Poverty or Social Exclusion - EU Map Overview

Note - Non-available data for Corsica NUTS 2 Region.

5.1.2 3-Year Evolution in Each NUTS2 Region

Considering the results for this same indicator among the different regions for a three-year time horizon (2018-2020), some aspects that would go unnoticed if it was only considered the year of 2020 can be detected. According to Figure 8, while the top 3 critical regions in 2020 were Sicilia, the Canary Islands, and Sardegna, in 2018, the regions with high rates of poverty or social exclusion were Sicily, Crete, and the Canary Islands. Such a result shows that the performance of Crete related to this indicator has been improving over the last three years. Although the rates are high for the Italian region of Sicily, they have been also declining over the past few years. Similar to what happened between these two regions, the numbers also tend to have dropped in the following NUTS 2 Regions: Southern Aegean (Νότιο Αιγαίο), Ionian Islands (Ιόνια Νησιά), Cyprus, Eastern & Midland, Åland Islands, and Hovedstaden.[47]

Contrary to the performance of these regions in the year 2018, the situation in 2020 appeared to be worse in some of them. Between 2018 and 2020, regions such as Madeira, Southern Ireland, the Balearic Islands, and Småland med öarna saw their poverty and social exclusion numbers increase. Such results may be related to the Covid-19 pandemic crisis. Finally, while the regions with the lowest rates related to such indicator in 2018 were Malta, Balearic Islands, and Småland med öarna, in 2020, the regions were as follows: Hovedstaden, Småland med öarna, and Eastern and Midland.

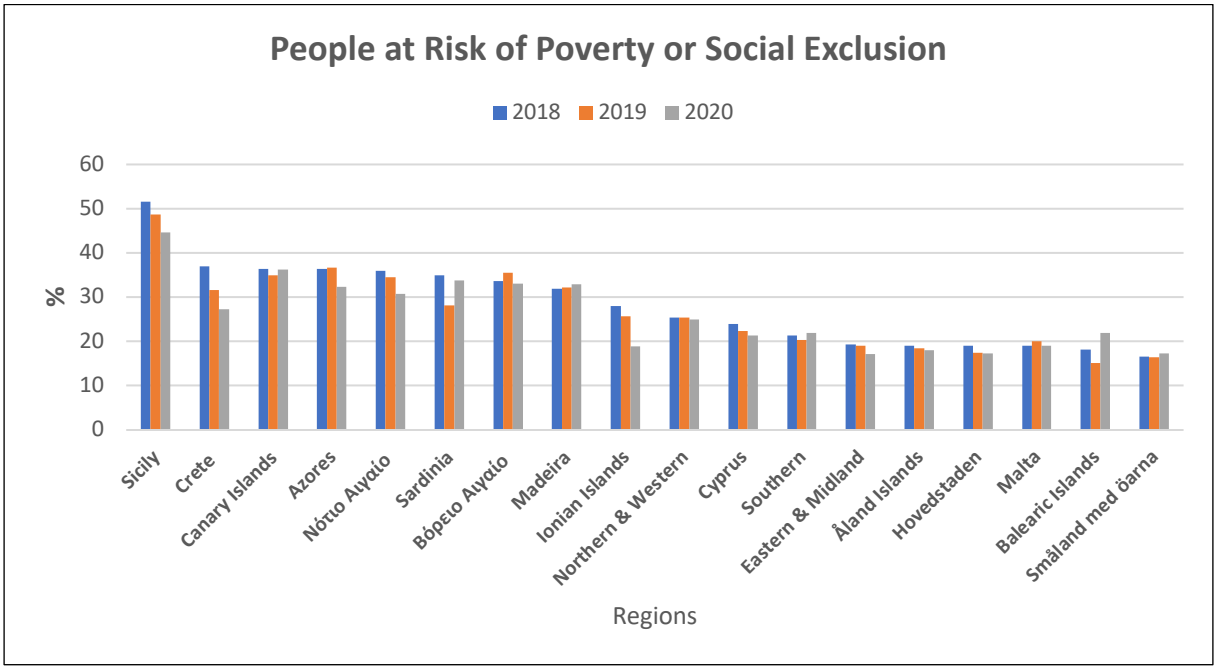

Figure 8 - People at Risk of Poverty or Social Exclusion in Each NUTS2 Region

5.1.3 Comparison to the Matching Country Average Value

Regarding the variation of poverty and social exclusion numbers between the NUTS 2 regions and their matching countries, through Table 5, different situations can be exploited. The difference/variation between such territories for 2020 was higher in the following regions: Sicily (76,7%), Madeira (66,2%), Açores (63,6%), and Canary Islands (37,5%). Such results reveal that the rates of poverty or social exclusion tend to be higher in island regions when compared to the rates associated with the respective countries, revealing that both Italian and Portuguese island regions are particularly vulnerable to this indicator. On the other hand, the following regions reveal a better performance compared to their associated country: Ionian Islands (Ιόνια Νησιά), Eastern & Midland, Balearic Island, and Crete.

Table 5 - People at Risk of Poverty or Social Exclusion – Variation Compared to the Country Avg. Value

People at Risk of Poverty or Social Exclusion (2020)				
NUTS 2 Region	**%**	**Member State**	**%**	**Variation (%)**
Cyprus	21,3	Cyprus	21,3	0,0%
Hovedstaden	17,3	Denmark	15,9	8,8%
North Aegean Region	33,1	Greece	28,8	14,9%
Southern Aegean Region	30,8			6,9%
Crete	27,3			-5,2%
Ionian Islands	18,9			-34,4%
Balearic Islands	22,0	Spain	26,4	-16,7%
Canary Islands	36,3			37,5%
Åland Islands	18,0	Finland	16	12,5%
Corsica	n/a	France	n/a	-
Northern & Western	25,0	Ireland	22	13,6%
Southern	21,9			-0,5%
Eastern & Midland	17,2			-21,8%
Sicily	44,7	Italy	25,3	76,7%
Sardinia	33,8			33,6%
Malta	19,0	Malta	19	0,0%
Azores	32,4	Portugal	19,8	63,6%
Madeira	32,9			66,2%
Småland and the islands	17,3	Sweden	17,9	-3,4%

5.2 People Living in Households with Very Low Work Intensity

5.2.1 EU Overview

As shown in Figure 9, where an EU overview of the indicator " People Living in Households with Very Low Work Intensity" is provided, there are significant differences across the distinct NUTS regions. The main hotspots are the Southern-European regions, specifically the Italian islands, followed by the North Aegean Region (Βόρειο Αιγαίο), where the numbers are: Sicily (23,2%), Sardinia (18,7%), and North Aegean Region (15,7%). In addition, both the Canary Islands and the Northern and Western regions (Ireland) present higher rates too. The regions with the lowest rates related to the indicator are: Malta (5,4%), the Ionian Islands (Ιόνια Νησιά – 5,4%), and the Balearic Islands (4,5%).

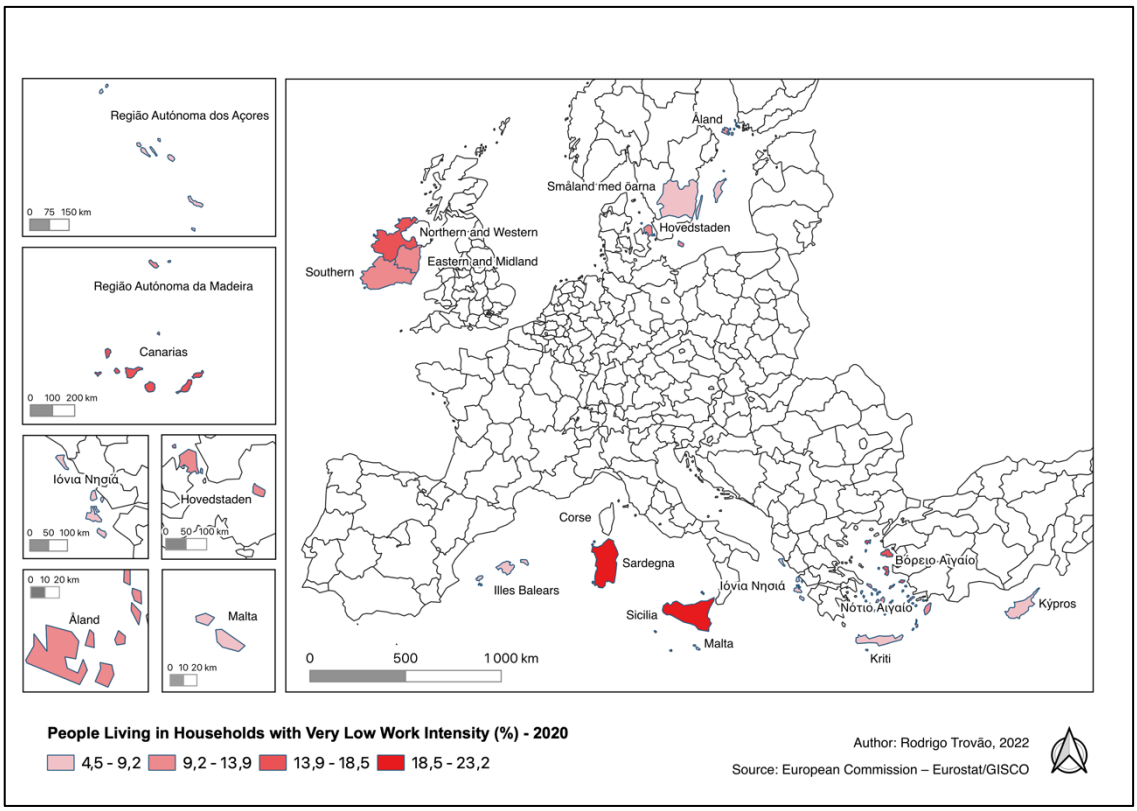

Figure 9 - People Living in Households with Very Low Work Intensity - EU Map Overview

Note - Non-available data for Corsica NUTS 2 Region.

5.2.2 3-Year Evolution in Each NUTS2 Region

Considering the results for the present indicator across all the NUTS2 for a three-year time horizon (2018-2020) some aspects that would go unnoticed if it was only considered the year of 2020, could be detected. As shown in Figure 10, the top 3 critical island regions in 2020 were Sicily, Sardegna, and the North Aegean Region (Βόρειο Αιγαίο). In 2018, the results were similar. The three regions with high rates of People Living in Households with Very Low Work Intensity were the same (Sicily, Sardinia, and the North Aegean Region). Although the rates are high for the Italian region of Sicily, they also have been declining over the past few years. The numbers also dropped in the following NUTS 2 Regions: Southern, Crete, Madeira, Ionian Islands, and Cyprus. There were some regions where the situation in 2019 appeared to be worse compared to 2018. Between 2018 and 2019, regions such as the Azores, Eastern & Midland, Southern Aegean (Νότιο Αιγαίο), and Småland med öarna saw their performance related to this indicator decrease.

Furthermore, the numbers in 2020 were even worse in some regions in comparison to that same year in 2019. Examples of this are the following regions: Sardinia, Northern & Western, North Aegean Region (Βόρειο Αιγαίο), Canary Islands, Aland Islands, Hovedstaden, Malta, and the Balearic Islands. Such results may be related to the Covid-19 pandemic crisis.

Finally, while the regions with the lowest rates related to such indicator in 2018 were Småland med öarna, Malta, and the Balearic Islands, in 2020, the regions were as follows: Malta, Ionian Islands, and the Balearic Islands.

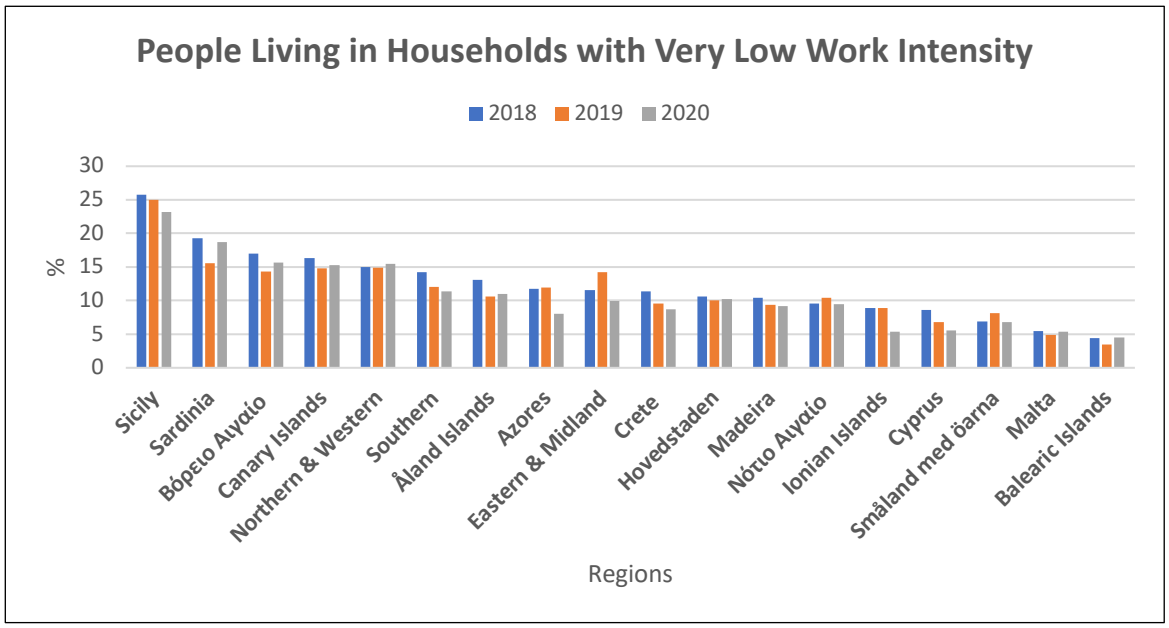

Figure 10 - People Living in Households with Very Low Work Intensity in Each NUTS2 Region

5.2.3 Comparison to the Matching Country Average Value

Regarding the variation numbers of people living in households with low-work intensity between the NUTS 2 regions and their matching countries, through Table 6, different situations can be explored. The difference/variation between such territories for 2020 was higher in the following regions: Sicily (110,9%), Madeira (80,4%), Sardinia (70,0%), and Azores (56,9%). Such results reveal that the rates of people in this critical situation tend to be higher in island regions when compared to the rates associated with the respective countries, revealing that both Italian and Portuguese island regions are particularly vulnerable to this indicator. On the other hand, the following regions indicate a better performance compared to their associated country: Ionian Islands (Ιόνια Νησιά), Balearic Islands, and Crete.

Table 6 - People Living in Households w/ Low Work Intensity – Variation Compared to the Country Avg. Value

People Living in Households with Very Low Work Intensity (2020)				
NUTS 2 Region	**%**	**Member State**	**%**	**Variation (%)**
Cyprus	5,6	Cyprus	5,6	0,0%
Hovedstaden	10,2	Denmark	9,1	12,1%
North Aegean Region	15,7	Greece	12,6	24,6%
Southern Aegean Region	9,5			-24,6%
Crete	8,7			-31,0%
Ionian Islands	5,4			-57,1%
Balearic Islands	4,5	Spain	9,9	-54,5%
Canary Islands	15,3			54,5%
Åland Islands	11,0	Finland	9,9	11,1%
Corsica	n/a	France	n/a	-
Northern & Western	15,5	Ireland	11,3	37,2%
Southern	11,4			0,9%
Eastern & Midland	9,9			-12,4%
Sicily	23,2	Italy	11	110,9%
Sardinia	18,7			70,0%
Malta	5,4	Malta	5,4	0,0%
Azores	8,0	Portugal	5,1	56,9%
Madeira	9,2			80,4%
Småland and the islands	6,8	Sweden	8,5	-20,0%

5.3 Severe Material Deprivation Rate

5.3.1 EU Overview

As shown in Figure 11, where an EU outline of the indicator "Severe Material Deprivation Rate" is provided in the different NUTS regions, the main hotspots are the Greek Islands, where the numbers are: Southern Aegean (Νότιο Αιγαίο – 20,9%), North Aegean Region (Βόρειο Αιγαίο – 19,0%), Crete (16,3%), and Ionian Islands (Ιόνια Νησιά -11,2%). In addition, both the Canary Islands and the Portuguese Islands (Azores and Madeira) present higher rates too. The regions with the lowest rates related to the indicator are: Hovedstaden (2,1%), Aland Islands(2,0%), and Småland med öarna (1,3%).

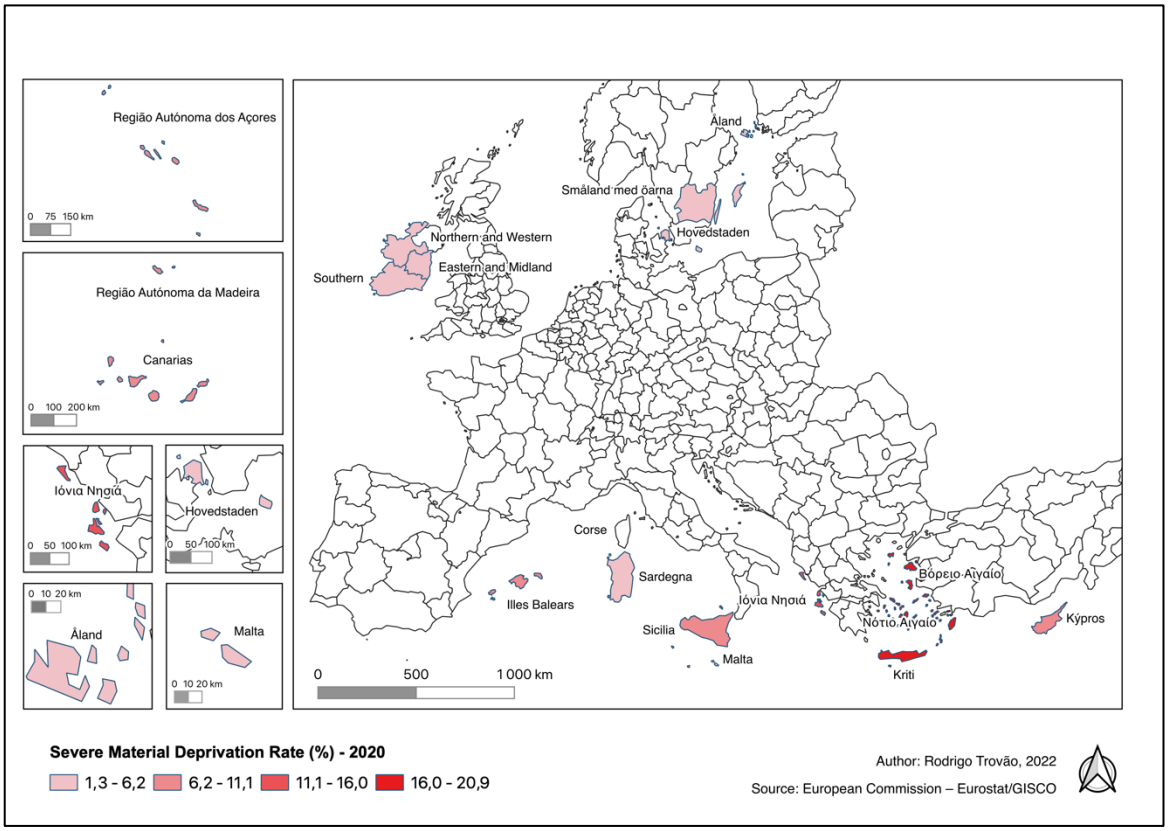

Figure 11 - Severe Material Deprivation Rate - EU Map Overview

Note - Non-available data for Corsica NUTS 2 Region.

5.3.2 3-Year Evolution in Each NUTS2 Region

Considering the results for the present indicator across all the NUTS2 for a three-year time horizon (2018-2020), some aspects that would go undetected if it was only considered the year of 2020, could be detected. As shown in Figure 11, while the top 3 critical regions in 2020 were Southern Aegean (Νότιο Αιγαίο), North Aegean Region (Βόρειο Αιγαίο), and Crete, in 2018, the 3 regions with high numbers of Severe Material Deprivation Rates were the following ones: Southern Aegean, Sicily, and Crete. Between 2018 and 2020, the numbers dropped in the following NUTS 2 Regions: Sicily, Ionian Islands, Sardinia, Eastern & Midland, Aland Islands, and Hovedstaden. On the other side, there were some regions where the situation in 2019 appeared to be worse when compared to 2018. Between 2018 and 2019, regions such as Southern Aegean (Νότιο Αιγαίο), Crete, North Aegean Region (Βόρειο Αιγαίο), Azores, Malta, and Southern (Ireland) saw the rates related to this indicator increase. Furthermore, the numbers in 2020 were even worse on some regions in comparison to that same year of 2019. Examples of this are the following regions: Madeira, Canary Islands, Balearic Islands, and Northern & Western. Such results may be related to the Covid-19 pandemic crisis.

Finally, while the regions with the lowest rates related to such indicator in 2018 were Småland med öarna, Southern (Ireland), and Malta, in 2020, the regions were as follows: Hovedstaden, Aland Islands, and Småland med öarna.

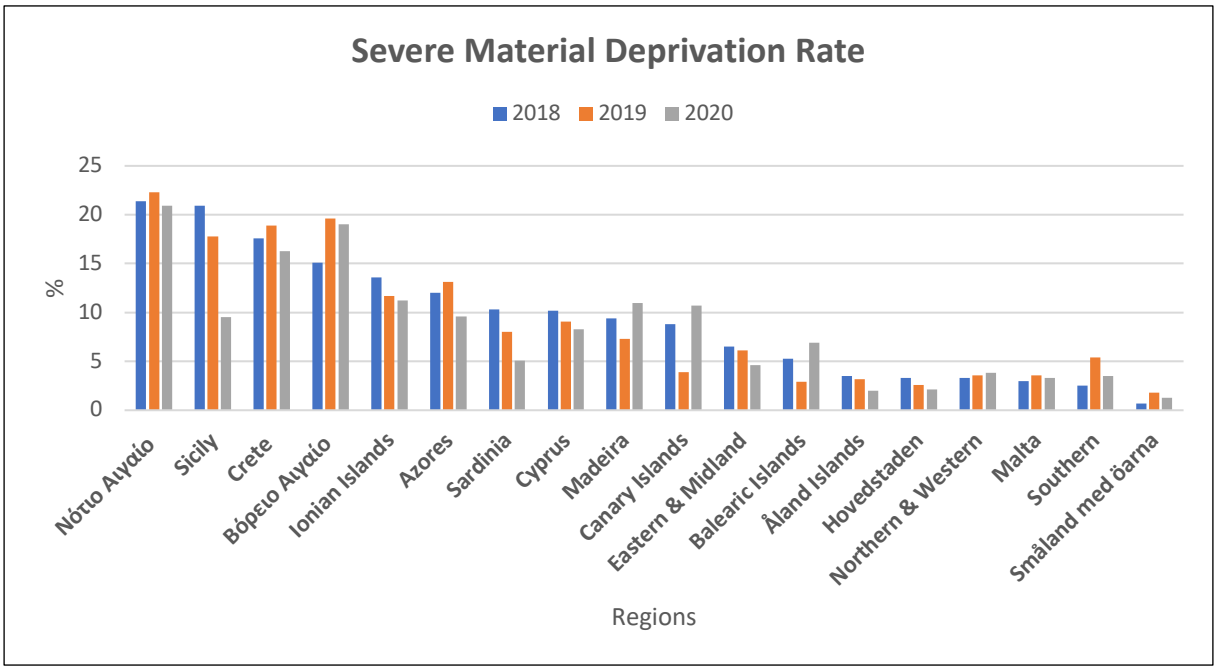

Figure 12 - Severe Material Deprivation Rate in Each NUTS2 Region

5.3.3 Comparison to the Matching Country Average Value

Regarding the variation between the NUTS 2 regions and their matching countries average value on the indicator "Severe Material Deprivation Rate", through Table 7 there are some different situations that can be explored. The variation between such territories for 2020, was higher in the following regions: Madeira (139,1%), Azores (108,7%), Sicily (61,0%), and Canary Islands (52,9%). Such results reveal that the rates of people in this critical situation tend to be higher in island regions when compared to the rates associated with the respective countries, revealing that Portuguese island regions are particularly vulnerable. On the other hand, the following regions reveal a better performance compared to their associated country: Åland Islands, Småland med öarna, and the Ionian Islands.

Table 7 - Severe Material Deprivation Rate – Variation Compared to the Country Avg. Value

Severe Material Deprivation Rate (2020)				
NUTS 2 Region	**%**	**Member State**	**%**	**Variation (%)**
Cyprus	8,3	Cyprus	8,3	0,0%
Hovedstaden	2,1	Denmark	2,4	-12,5%
North Aegean Region	19,0	Greece	16,6	14,5%
Southern Aegean Region	20,9			25,9%
Crete	16,3			-1,8%
Ionian Islands	11,2			-32,5%
Balearic Islands	6,9	Spain	7	-1,4%
Canary Islands	10,7			52,9%
Åland Islands	2,0	Finland	2,6	-23,1%
Corsica	n/a	France	n/a	-
Northern & Western	3,8	Ireland	4,1	-7,3%
Southern	3,5			-14,6%
Eastern & Midland	4,6			12,2%
Sicily	9,5	Italy	5,9	61,0%
Sardinia	5,1			-13,6%
Malta	3,3	Malta	3,3	0,0%
Azores	9,6	Portugal	4,6	108,7%
Madeira	11,0			139,1%
Småland and the islands	1,3	Sweden	1,8	-27,8%

5.4 At-Risk of Poverty Rate

5.4.1 EU Overview

As shown in Figure 13, where an EU overview related to the indicator "At-Risk-of-Poverty Rate" is provided across the NUTS2 regions, the main hotspots are the Italian and Portuguese Islands where the numbers are: Sicily (38,2%), Sardegna (28,6%), Azores (28,5%), and Madeira (26,3%). The regions with the lowest rates related to the indicator are: Hovedstaden (12,7%), Eastern & Midland Ireland (10,4%), and Ionian Islands (Ιόνια Νησιά -10%).

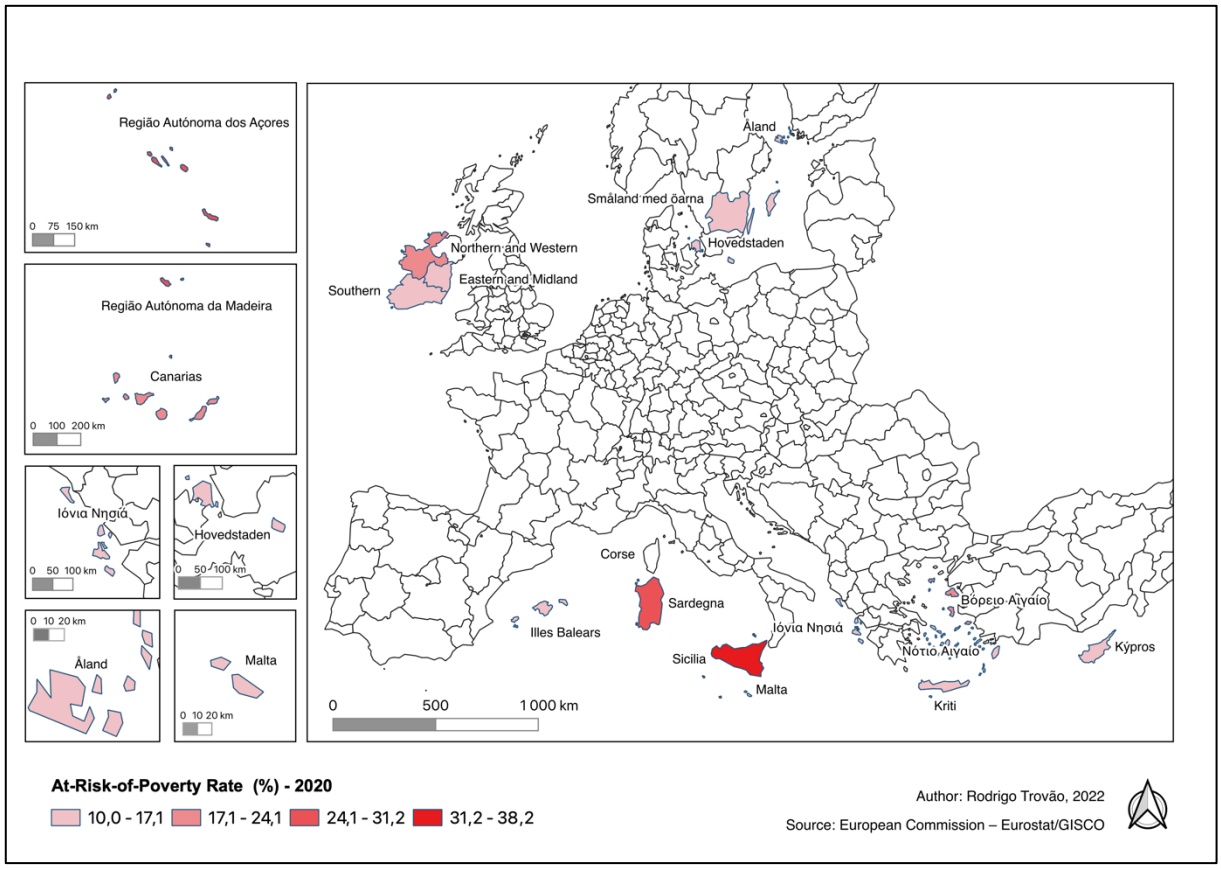

Figure 13 – At-Risk-of-Poverty Rate - EU Map Overview

Note - Non-available data for Corsica NUTS 2 Region.

5.4.2 3-Year Evolution in Each NUTS2 Region

Considering the results for the present indicator across all the NUTS2 for a three-year time horizon (2018-2020), some aspects that would go undetected if it was only considered the year of 2020, can be detected. As shown in Figure 14, while the top 3 critical regions in 2020 were Sicily, Sardegna, and Azores, in 2018, the 3 regions with high numbers related to the indicator ´At-Risk-of-Poverty Rate´ were the following ones: Sicily, Canary Islands, and Azores. From here, it can concluded that the rates in the Canary Islands have been decreasing over the years. Between 2018 and 2020, the numbers tend to have dropped in the following NUTS 2 Regions: Crete, Southern Aegean (Νότιο Αιγαίο), Ionian Islands, Cyprus, Hovedstaden, and Eastern & Midland (Ireland). On the other side, there were some regions where the situation in 2019 appeared to be worse when compared to 2018. Between 2018 and 2019, regions such as Sicily, Azores, Madeira, Malta, and Aland Islands saw the rates related to this indicator increase. Furthermore, the numbers in 2020 were even worse on some regions in comparison to that same year of 2019. Examples of this are the following regions: Sardegna, North Aegean Region (Βόρειο Αιγαίο), Southern (Ireland), and Småland med öarna. Such results may be related to the Covid-19 pandemic crisis.

Finally, while the regions with the lowest rates related to such indicator in 2018 were Hovedstaden, Aland Islands, and Eastern & Midland, in 2020, the regions were as follows: Hovedstaden, Eastern & Midland Ireland, and Ionian Islands.

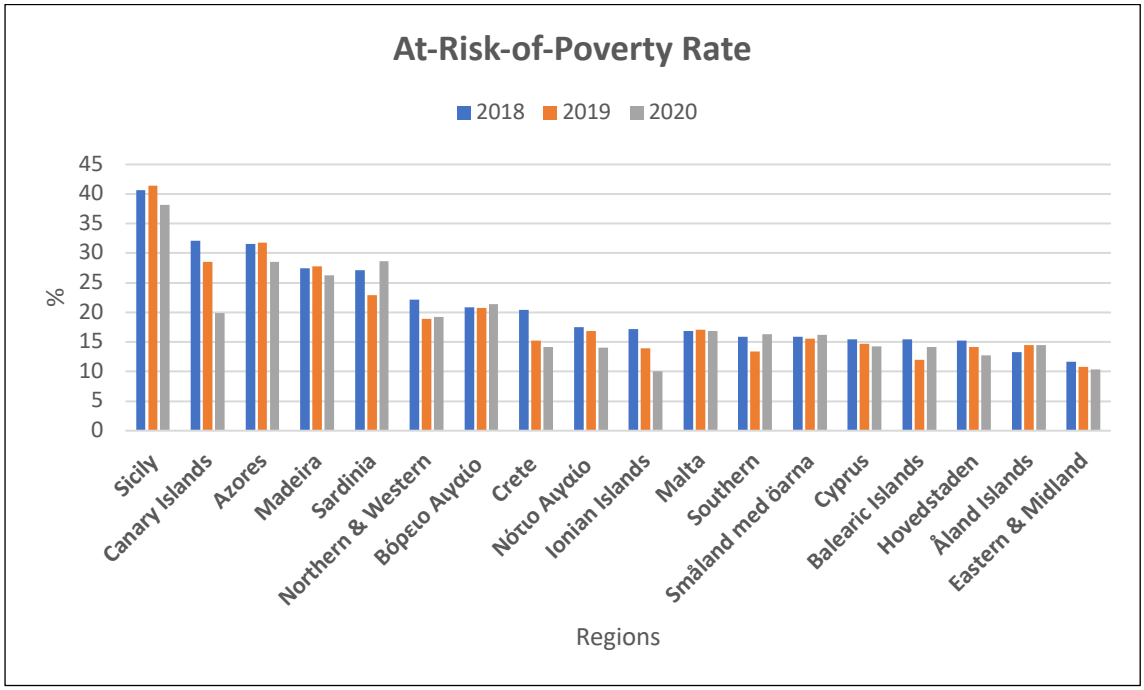

Figure 14 - At-Risk-of-Poverty Rate In Each NUTS2 Region NUTS2

5.4.3 Comparison to the Matching Country Average Value

Regarding the variation between the NUTS 2 regions and their matching countries average value on the indicator ´At-Risk-of-Poverty Rate´, through Table 8 there are some different situations that can be explored. The variation between such territories for 2020, was higher in the following regions: Sicily (91,0%), Azores (75,9%), and Madeira (62,3%). Such results reveal that the rates of people in this critical situation tend to be higher in island regions when compared to the rates associated with the respective countries, revealing that both Italian and Portuguese island regions are particularly vulnerable. On the other hand, the following regions reveal a better performance compared to their associated country: Eastern & Midland, Balearic Islands, and the Ionian Islands.

Table 8 - At-Risk-of-Poverty Rate – Variation Compared to the Country Avg. Value

At-Risk-of-Poverty Rate (2020)				
NUTS 2 Region	**%**	**Member State**	**%**	**Variation (%)**
Cyprus	14,3	Cyprus	14,3	0,0%
Hovedstaden	12,7	Denmark	12,1	5,0%
North Aegean Region	21,4	Greece	17,7	20,9%
Southern Aegean Region	14,0			-20,9%
Crete	14,1			-20,3%
Ionian Islands	10,0			-43,5%
Balearic Islands	14,1	Spain	21	-32,9%
Canary Islands	19,9			-5,2%
Åland Islands	14,5	Finland	12,2	18,9%
Corsica	n/a	France	n/a	-
Northern & Western	19,2	Ireland	13,8	39,1%
Southern	16,3			18,1%
Eastern & Midland	10,4			-24,6%
Sicily	38,2	Italy	20	91,0%
Sardinia	28,6			43,0%
Malta	16,9	Malta	16,9	0,0%
Azores	28,5	Portugal	16,2	75,9%
Madeira	26,3			62,3%
Småland and the islands	16,2	Sweden	16,1	0,6%

5.5 At-Risk of Poverty Rate Before Social Transfers

5.5.1 EU Overview

As shown in Figure 15, where an EU overview related to the indicator ´At-Risk-of-Poverty Rate Before Social Transfers´ is provided across the NUTS2 regions, the main hotspots are the Italian and Irish Islands where the numbers are: Sicily (47,2%), Northern & Western (39,0%), and Sardegna (33,9%). The regions with the lowest rates related to the indicator are: Malta (21,4%), the Ionian Islands (Ιόνια Νησιά – 20,1%), and Crete (19,9%).

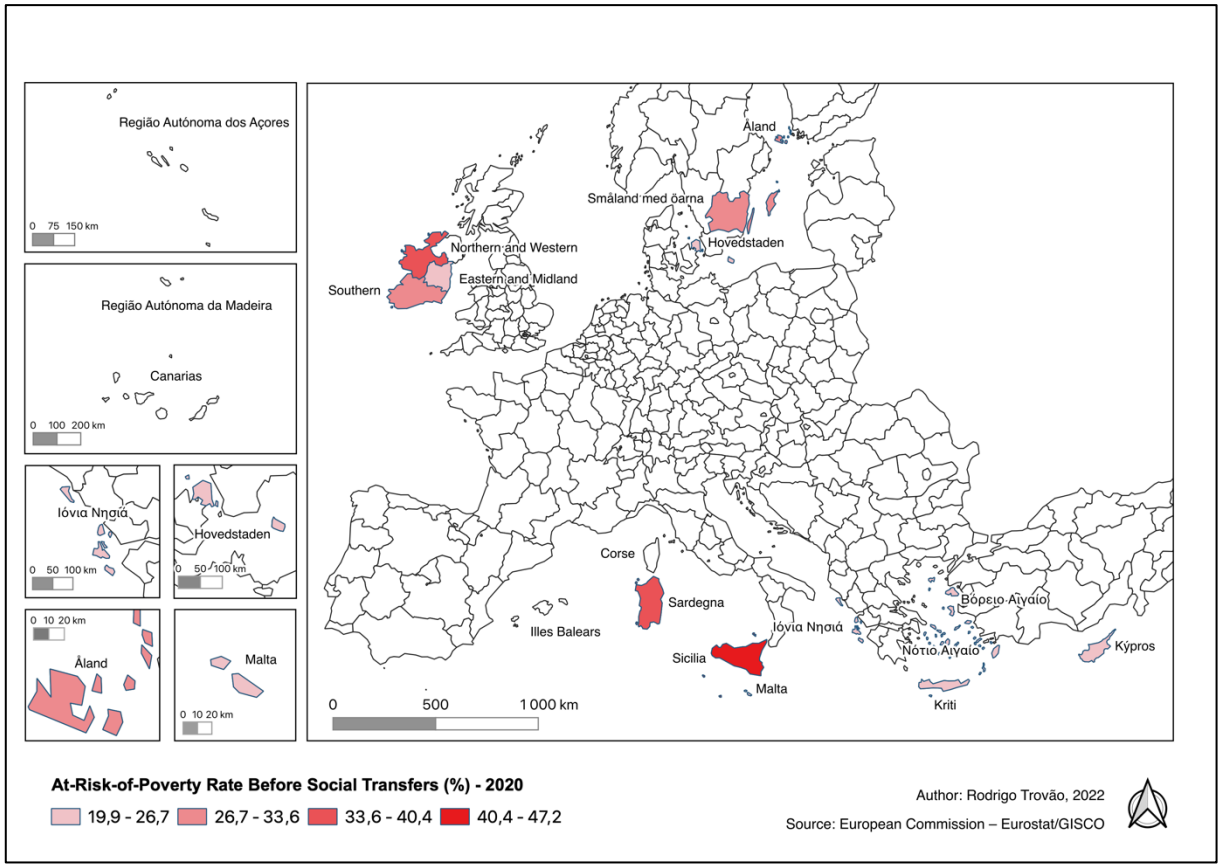

Figure 15 - At-Risk-of-Poverty Rate Before Social Transfers – EU Map Overview

Note - Non-available data for the following regions: Canary Islands, Madeira, Azores, Balearic Islands, and Corse.

5.5.2 3-Year Evolution in Each NUTS2 Region

Considering the results for the present indicator across all the NUTS2 for a three-year time horizon (2018-2020), some aspects that would go undetected if it was only considered the year of 2020, can be detected. As shown in Figure 16, while the top 3 critical regions in 2020 were Sicily, Northern & Western, and Sardegna, in 2018, the 3 regions with high numbers related to the indicator ´At-Risk-of-Poverty Rate Before Social Transfers´ were the same. Between 2018 and 2020, the numbers tend to have dropped in the following NUTS 2 Regions: Sicily, Aland Islands, Eastern & Midland, Crete, Cyprus, Malta, and the Ionian Islands. On the other side, there were some regions where the situation in 2019 appeared to be worse when compared to 2018. Between 2018 and 2019, regions such as Northern & Western, Southern, North Aegean Region (Βόρειο Αιγαίο), and Southern Aegean (Νότιο Αιγαίο) saw the rates related to this indicator increase. Furthermore, the numbers in 2020 were even worse on some regions in comparison to that same year of 2019. Examples of this are the following regions: Northern & Western, Sardegna, Småland med öarna, and Hovedstaden. Such results may be related to the Covid-19 pandemic crisis.

Finally, while the regions with the lowest rates related to such indicator in 2018 were Malta, Southern Aegean (Νότιο Αιγαίο), and the Ionian Islands, in 2020, the regions were as follows: Malta, Ionian Islands (Ιόνια Νησιά), and Crete.

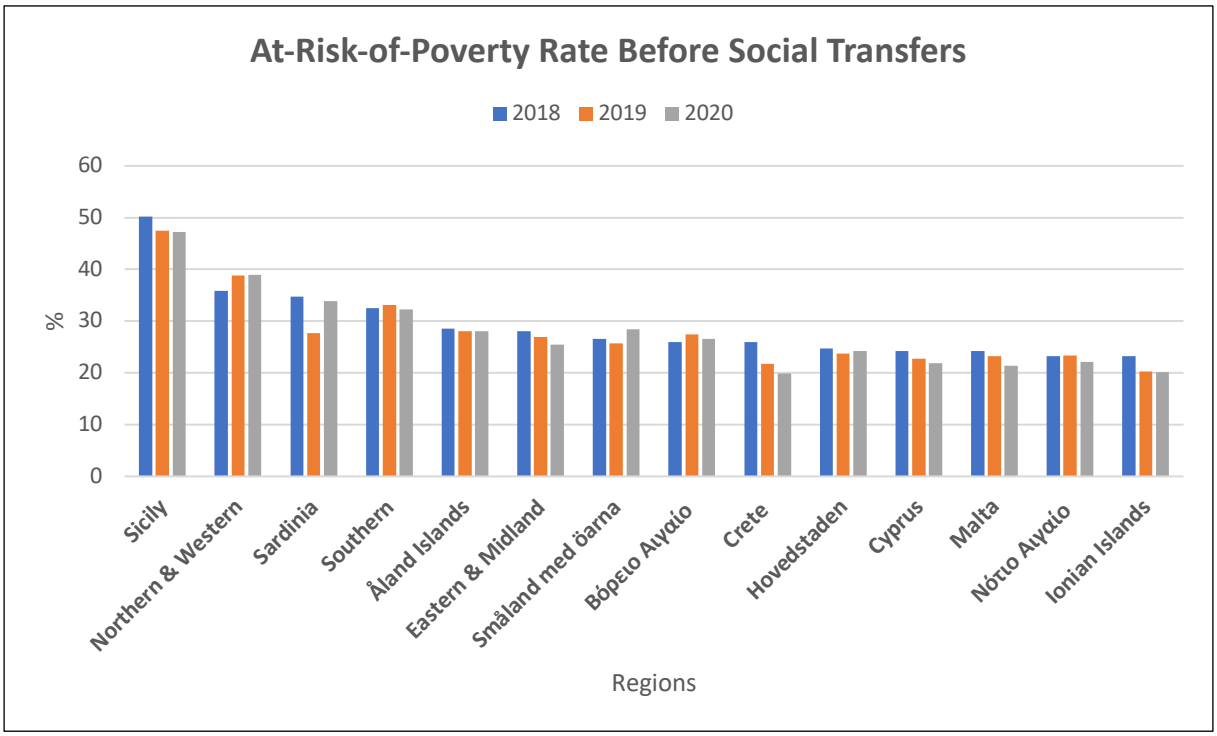

Figure 16 - At-Risk-of-Poverty Rate In Each NUTS2 Region NUTS2

5.5.3 Comparison to the Matching Country Average Value

Regarding the variation between the NUTS 2 regions and their matching countries average value on the indicator ´At-Risk-of-Poverty Rate Before Social Transfers´, through Table 9 there are some different situations that can be explored. The variation between such territories for 2020, was higher in the following regions: Sicily (86,6%), Sardegna (34,0%), and Northern & Western (30,4%). Such results reveal that the rates of people in this critical situation tend to be higher in island regions when compared to the rates associated with the respective countries, revealing that Italian Island regions are particularly vulnerable. On the other hand, the following regions reveal a better performance compared to their associated country: the Ionian Islands, Eastern & Midland, and Crete.

Table 9 - At-Risk-of-Poverty Before Social Rate Transfers – Variation Compared to the Country Avg. Value

At-Risk-of-Poverty Rate Before Social Transfers (2020)				
NUTS 2 Region	**%**	**Member State**	**%**	**Variation (%)**
Cyprus	21,9	Cyprus	21,9	0,0%
Hovedstaden	24,2	Denmark	25,4	-4,7%
North Aegean Region	26,6	Greece	23,5	13,2%
Southern Aegean Region	22,1			-6,0%
Crete	19,9			-15,3%
Ionian Islands	20,1			-14,5%
Balearic Islands	n/a	Spain	27,4	-
Canary Islands	n/a			-
Åland Islands	28,0	Finland	25,1	11,6%
Corsica	n/a	France	n/a	-
Northern & Western	39,0	Ireland	29,9	30,4%
Southern	32,3			8,0%
Eastern & Midland	25,5			-14,7%
Sicily	47,2	Italy	25,3	86,6%
Sardinia	33,9			34,0%
Malta	21,4	Malta	21,4	0,0%
Azores	n/a	Portugal	n/a	-
Madeira	n/a			-
Småland and the islands	28,4	Sweden	28,1	1,1%

5.6 Income Quintile Share Ratio S80/S20

5.6.1 EU Overview

As shown in Figure 17, where an EU overview related to the indicator ´Income Quintile Share Ratio S80/S20´ is provided across the NUTS2 regions, it can noticed that both the Italian Islands as well as the Canary Islands present higher rates, where the numbers are: Sicily (7,5%), Sardegna (7,3%), and Canary Islands (6,9%). According to the EU overview, the regions with the lowest rates related to the indicator are: Southern (3,8%), Northern & Western (3,6%), and Aland Islands (3,6%).

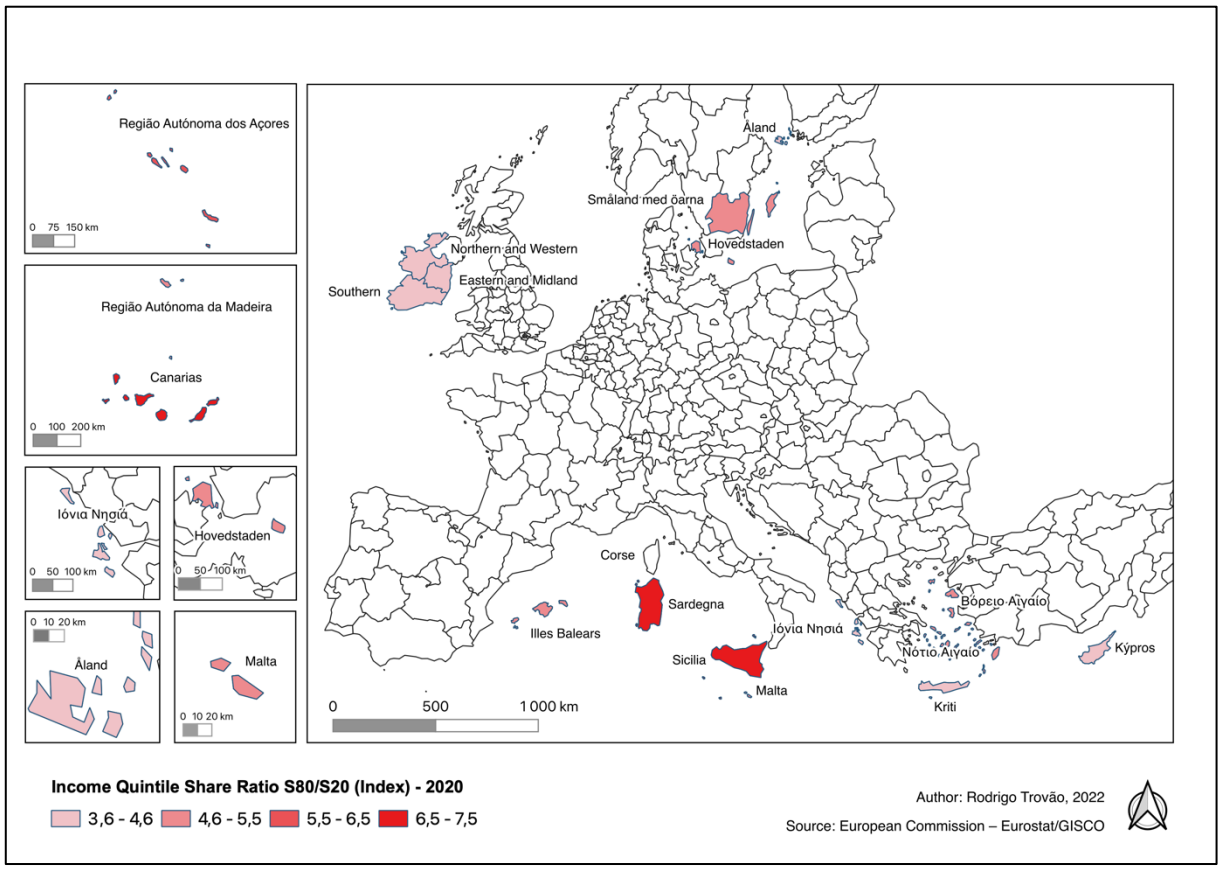

Figure 17 - Income Quintile Share Ratio S80/S20 – EU Map Overview

Note - Non-available data for Corsica NUTS 2 Region.

5.6.2 3-Year Evolution in Each NUTS2 Region

Considering the results for the present indicator across all the NUTS2 for a three-year time horizon (2018-2020), some aspects that would go undetected if it was only considered the year of 2020, can be detected. As shown in Figure 18, while the top 3 critical regions in 2020 were Sicily, Sardegna, and the Canary Islands, in 2018, the 3 regions with high numbers related to the indicator ´Income Quintile Share Ratio S80/S20´ were the same but on that same year, the Canary Islands were the second worst region instead of the third. Between 2018 and 2020, the numbers tend to have dropped in the following NUTS 2 Regions: Azores, Balearic Islands, Hovedstaden, Ionian Islands, Crete, and Northern & Western. On the other side, there were some regions where the situation in 2019 appeared to be worse when compared to 2018. Between 2018 and 2019, regions such as Sicily, North Aegean Region (Βόρειο Αιγαίο), Southern Aegean (Νότιο Αιγαίο), Cyprus, Småland med öarna, and Southern, saw the proportions related to this indicator increase. Furthermore, the numbers in 2020 were even worse on some regions in comparison to that same year of 2019. Examples of this are the following regions: Canary Islands, Sardegna, Madeira, Malta, and Aland Islands. Such results may be related to the Covid-19 pandemic crisis.

Finally, while the regions with the lowest rates related to such indicator in 2018 were Southern, Northern & Western, and Aland Islands, in 2020, the regions were exactly the same.

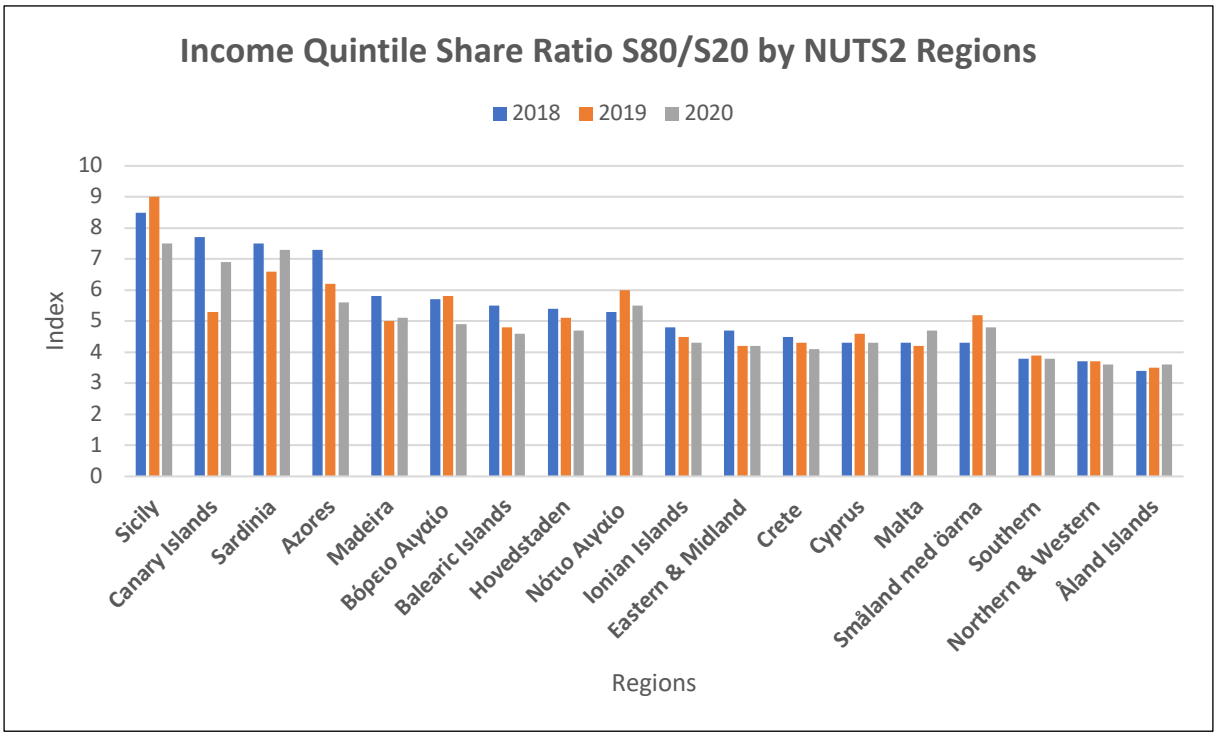

Figure 18 - Income Quintile Share Ratio S80/S20 In Each NUTS2 Region NUTS2

5.6.3 Comparison to the Matching Country Average Value

Regarding the variation between the NUTS 2 regions and their matching countries average value on the indicator ´Income Quintile Share Ratio S80/S20´, through Table 10 there are some different situations that can be explored. The variation between such territories for 2020, was higher in the following regions: Sicily (29,3%), Sardegna (25,9%), and the Canary Islands (19,0%). Such results show that in these regions the difference in income distribution is greater when compared with their respective countries, revealing that Italian, as well as the Canary Island regions, are particularly vulnerable to this indicator. On the other hand, the following regions reveal a better performance compared to their associated country: the Ionian Islands, Balearic Islands, and Crete.

Table 10 - Income Quintile Share Ratio S80/S20 – Variation Compared to the Country Avg. Value

Income Quintile Share Ratio S80/S20 (2020)				
NUTS 2 Region	**Index**	**Member State**	**Index**	**Variation (%)**
Cyprus	4,3	Cyprus	4,3	0,0%
Hovedstaden	4,7	Denmark	4	17,5%
North Aegean Region	4,9	Greece	5,2	-5,8%
Southern Aegean Region	5,5			5,8%
Crete	4,1			-21,2%
Ionian Islands	4,3			-17,3%
Balearic Islands	4,6	Spain	5,8	-20,7%
Canary Islands	6,9			19,0%
Åland Islands	3,6	Finland	3,7	-2,7%
Corsica	n/a	France	n/a	-
Northern & Western	3,6	Ireland	4,1	-12,2%
Southern	3,8			-7,3%
Eastern & Midland	4,2			2,4%
Sicily	7,5	Italy	5,8	29,3%
Sardinia	7,3			25,9%
Malta	4,7	Malta	4,7	0,0%
Azores	5,6	Portugal	5,7	-1,8%
Madeira	5,1			-10,5%
Småland and the islands	4,8	Sweden	4,1	17,1%

5.6.4 Annual Income - Comparison to the Matching Country Avg Value

The variation between such territories for 2019, was higher in the following regions: Southern Aegean (Νότιο Αιγαίο – 28,2%), Ionian Islands (22,7%), and Hovedstaden (15,5%). Such results reveal that the annual income tends to be higher in those island regions when compared to the rates associated with the respective countries. On the other hand, the following regions reveal to have fewer annual incomes when compared to their countries, with significant negative variations: Northern & Western, Sardinia, and Sicily.

Table 11 - Income of households by NUTS 2 regions - Variation Compared to the Country Avg. Value

Household Annual Income (2019) (€ per inhabitant/year)				
NUTS 2 Region	**Annual Income**	**Member State**	**Annual Income**	**Variation (%)**
Cyprus	16300	Cyprus	16300	0,0%
Hovedstaden	36600	Denmark	31700	15,5%
North Aegean Region	9200	Greece	11000	-16,4%
Southern Aegean Region	14100			28,2%
Crete	10500			-4,5%
Ionian Islands	13500			22,7%
Balearic Islands	18900	Spain	17100	10,5%
Canary Islands	14200			-17,0%
Åland Islands	28800	Finland	25200	14,3%
Corsica	20800	France	23400	-11,1%
Northern & Western	20000	Ireland	25800	-22,5%
Southern	23800			-7,8%
Eastern & Midland	29300			13,6%
Sicily	12900	Italy	20200	-36,1%
Sardinia	14700			-27,2%
Malta	n/a	Malta	n/a	n/a
Azores	12100	Portugal	12700	-4,7%
Madeira	11300			-11,0%
Småland and the islands	23700	Sweden	26500	-10,6%

5.7 Material and Social Deprivation Rate

5.7.1 EU Overview

As shown in Figure 19, where an EU overview related to the indicator ´Material and Social Deprivation Rate´ is provided across all the NUTS2 regions, it can noticed that the Greek Islands present the highest rates, where the numbers are: Crete (32,3%), North Aegean Region (Βόρειο Αιγαίο – 30,8%), Southern Aegean (Νότιο Αιγαίο – 29,4%). The Canary Islands revealed to be very vulnerable too, where the rate is 29%. According to the EU overview, the regions with the lowest rates related to the indicator are the Nordic Regions: Hovedstaden (5,6%), Småland med öarna (4,4%), and Aland Islands (4,3%).

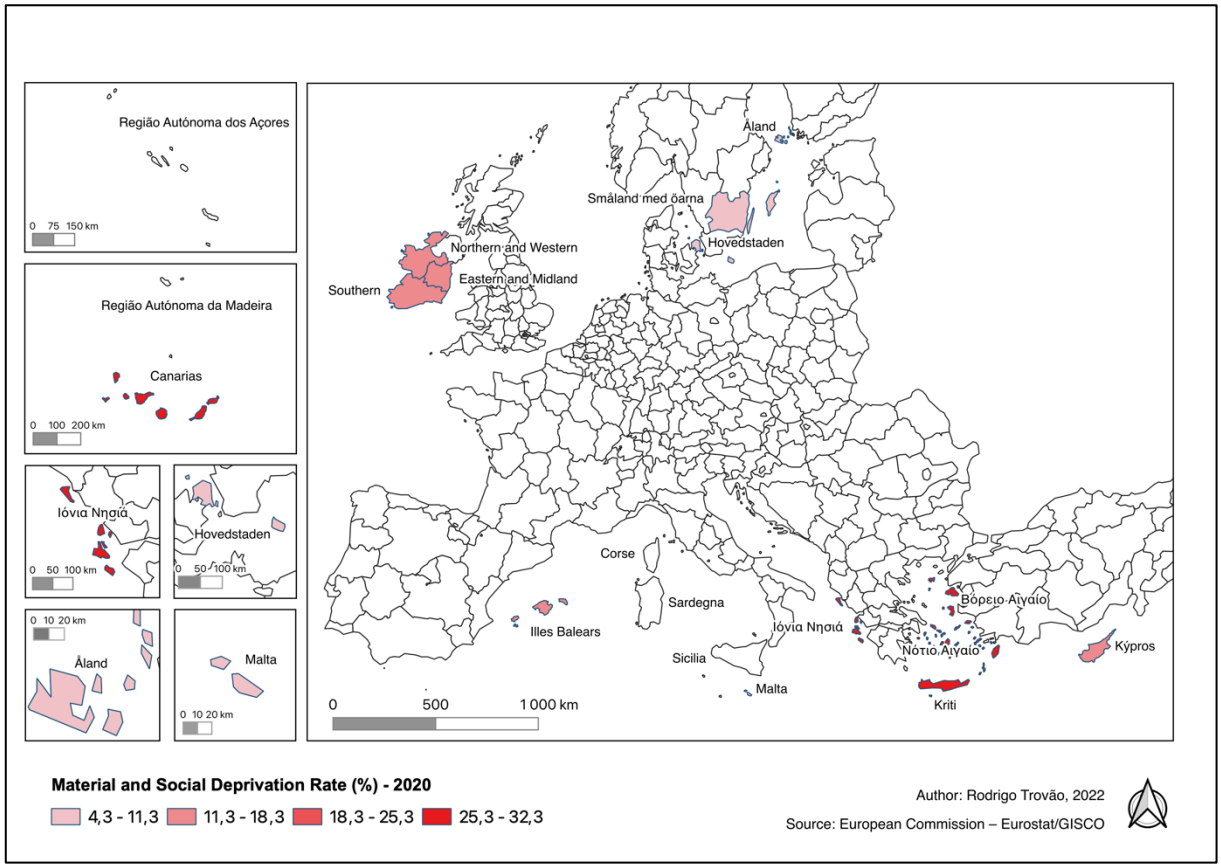

Figure 19 - Material and Social Deprivation Rate - EU Map Overview

Note - Non-available data for the following NUTS2 Regions: Sicily, Sardinia, Azores, Madeira, and Corse.

5.7.2 3-Year Evolution in Each NUTS2 Region

Considering the results for the present indicator across all the NUTS2 for a three-year time horizon (2018-2020), some aspects that would go undetected if it was only considered the year of 2020, can be detected. As shown in Figure 20, while the top 3 critical regions in 2020 were Crete, North Aegean Region (Βόρειο Αιγαίο), Southern Aegean (Νότιο Αιγαίο), in 2018, the 3 regions with high numbers related to the indicator ´Material and Social Deprivation Rate´ were the same, but with the Southern Aegean region as the second worst instead of the third. Between 2018 and 2020, the numbers tend to have dropped in the following NUTS 2 Regions: Crete, Southern Aegean, Cyprus, Southern, Hovedstaden, and Aland Islands. On the other side, there were some regions where the situation in 2019 appeared to be worse when compared to 2018. Between 2018 and 2019, regions such as the North Aegean Region, Northern & Western, Eastern & Midland, Balearic Islands, Malta, and Småland med öarna, saw their material and social deprivation rates increase. Furthermore, the numbers in 2020 were even worse on some regions in comparison to that same year of 2019. Examples of this are the following regions: the Canary Islands, Balearic Islands, and Småland med öarna.

Lastly, while the three regions with the lowest rates related to such indicator in 2018 were Hovedstaden, Aland Islands, and Småland med öarna, in 2020, the regions were exactly the same.

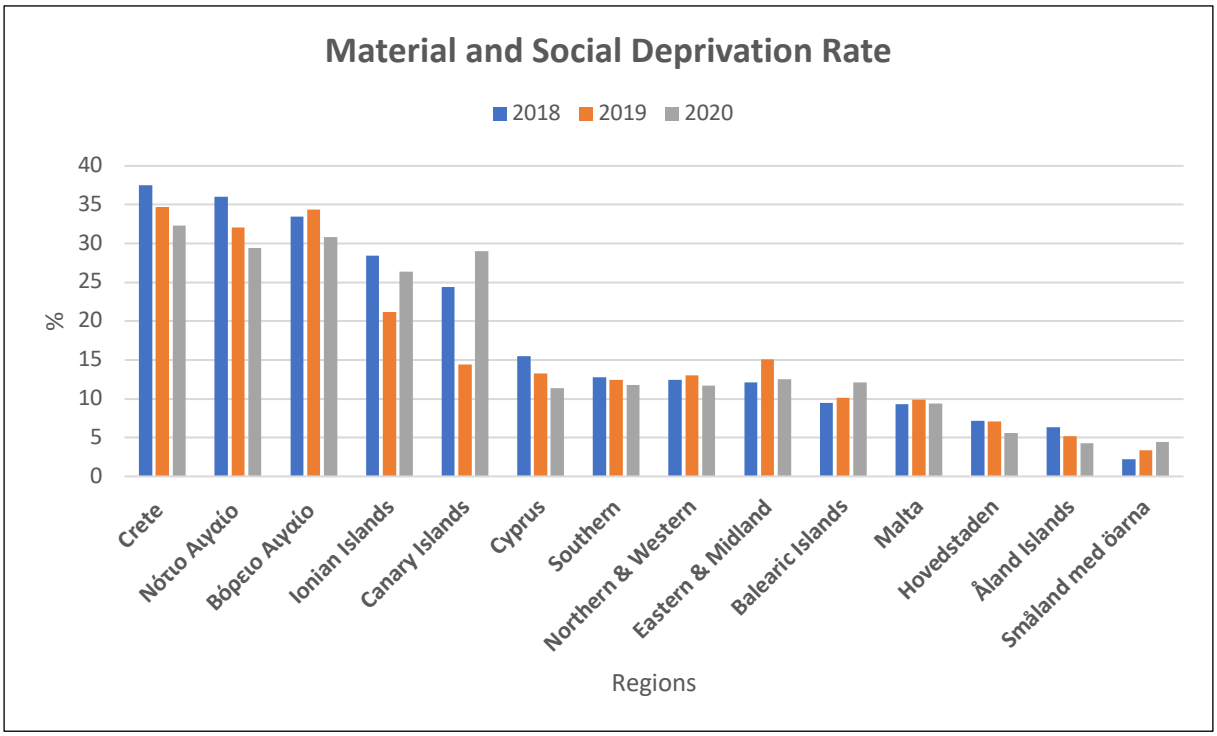

Figure 20 - Material and Social Deprivation Rate In Each NUTS2 Region NUTS2

5.7.3 Comparison to the Matching Country Average Value

Regarding the variation between the NUTS 2 regions and their matching countries average value on the indicator ´Material and Social Deprivation Rate´, through Table 12 there are some different situations that can be explored. The variation between such territories for 2020 was higher in the following regions: Canary Islands (88,3%), Småland med öarna (12,8%), and Crete (5,2%). Such results reveal that the rates of people in this critical situation tend to be higher in island regions when compared to the rates associated with the respective countries. Also, there is an interesting result where Småland med öarna, despite being one of the regions presenting the lowest material and social deprivation rates, is one of the regions where the variation compared to the member state (Sweden) is one of the highest. On the other hand, the following regions reveal a better performance compared to their associated country/member state: Ionian Islands, Hovedstaden, and the Balearic Islands.

Table 12 - Material and Social Deprivation Rate - Variation Compared to the Country Avg. Value

Material and Social Deprivation Rate (2020)				
NUTS 2 Region	**%**	**Member State**	**%**	**Variation (%)**
Cyprus	11,4	Cyprus	11,4	0,0%
Hovedstaden	5,6	Denmark	6,6	-15,2%
North Aegean Region	30,8	Greece	30,7	0,3%
Southern Aegean Region	29,4			-4,2%
Crete	32,3			5,2%
Ionian Islands	26,4			-14,0%
Balearic Islands	12,1	Spain	15,4	-21,4%
Canary Islands	29,0			88,3%
Åland Islands	4,3	Finland	4,6	-6,5%
Corsica	n/a	France	n/a	-
Northern & Western	11,7	Ireland	12,1	-3,3%
Southern	11,8			-2,5%
Eastern & Midland	12,5			3,3%
Sicily	n/a	Italy	11	-
Sardinia	n/a			-
Malta	9,4	Malta	9,4	0,0%
Azores	n/a	Portugal	12,7	-
Madeira	n/a			-
Småland and the islands	4,4	Sweden	3,9	12,8%

5.8 Average Number of Rooms per Person

5.8.1 EU Overview

As shown in Figure 21, where an EU overview related to the indicator ´Average Number of Rooms per Person´ is provided across all the NUTS2 regions, it can noticed that the Greek Islands are the most vulnerable regions, where the numbers are: Crete (1,3), Ionian Islands (1,3), and Southern Aegean (Νότιο Αιγαίο – 1,2). Such results reveal that in these regions, people tend to live in overcrowded housing conditions compared to the other regions. According to the EU overview, the regions with the highest number of rooms per person are Northern & Western (2,3), Southern (2,3), and Malta (2,3).

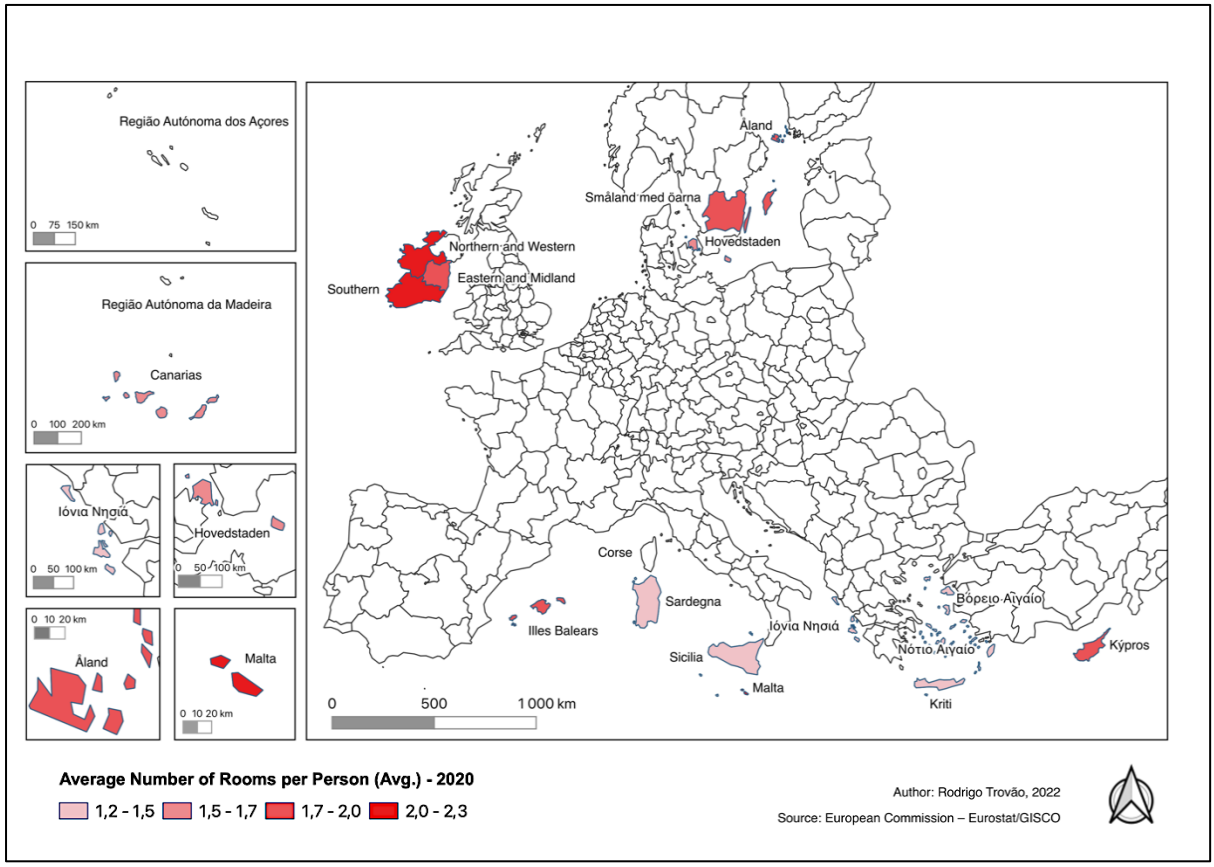

Figure 21 – Average Number of Rooms per Person – EU Map Overview

Note - Non-available data for the following NUTS2 Regions: Azores, Madeira, and Corse.

5.8.2 3-Year Evolution in Each NUTS2 Region

As shown in Figure 22, the results across all the NUTS2 for a three-year time horizon (2018-2020) were similar, with minor differences and variations. While the top 3 critical regions in 2020 were Crete, Ionian Islands, and Southern Aegean (Νότιο Αιγαίο), in 2018, the three regions with the lowest numbers related to the indicator ´Average Number of Rooms per Person´ were the same. Between 2019 and 2020, regions such as Southern, Northern & Western, and Malta, saw their (average) number of rooms per person increase. While the three regions with the highest number of rooms per person in 2018 were Southern, Northern & Western, and Malta, in 2020, were the same too.

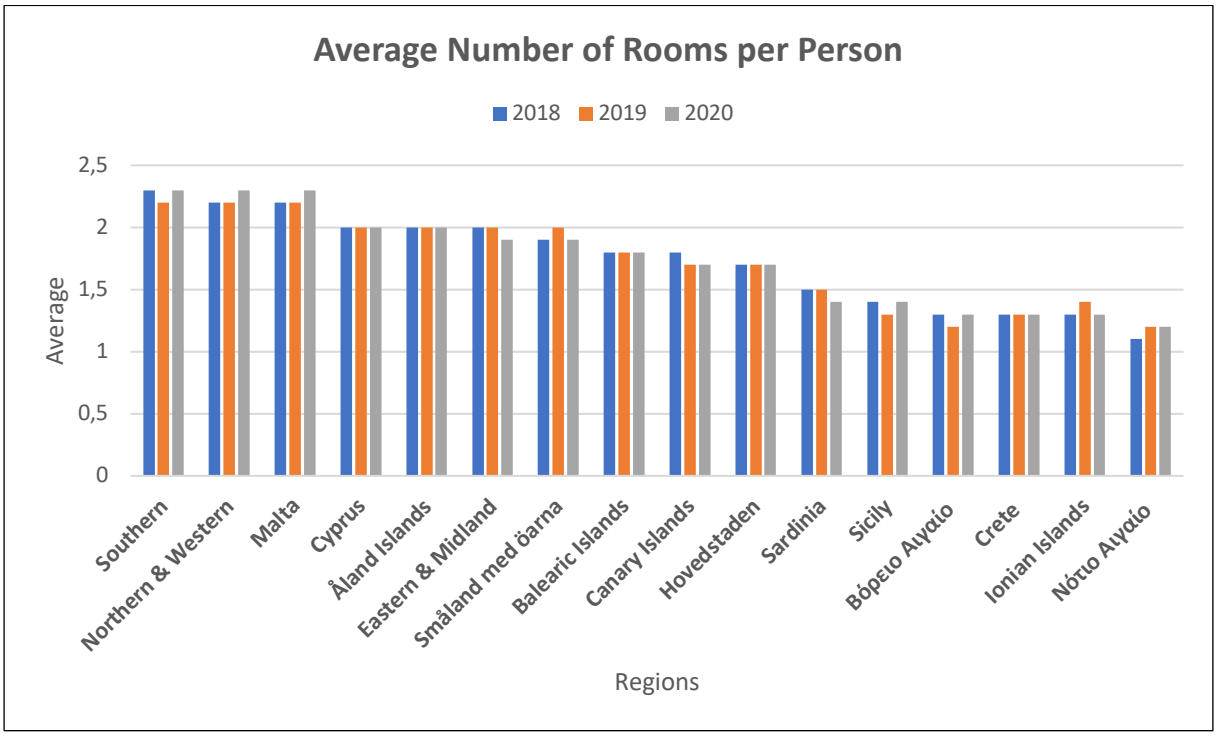

Figure 22 – Average Number of Rooms per Person In Each NUTS2 Region NUTS2

5.8.3 Comparison to the Matching Country Average Value

Regarding the variation between the NUTS 2 regions and their matching countries average value on the indicator ´Average Number of Rooms per Person´, through Table 13 there are some different situations that can be explored. The variation between such territories for 2020 was higher in the following regions: Småland med öarna (11,8%), Northern & Western (9,5%), and Southern (9,5%). Such results reveal that the number of rooms per person tends to be higher when compared to the rates associated with the respective countries, revealing that in these regions, people tend to live in less overcrowded housing conditions. On the other hand, the following regions reveal people living in most overcrowded houses compared to their countries, with significant negative variations: Eastern & Midland, Hovedstaden, and the Canary Islands.

Table 13 - Average Number of Rooms per Person – Variation Compared to the Country Avg. Value

Average Number of Rooms per Person (2020)				
NUTS 2 Region	**Avg.**	**Member State**	**Avg.**	**Variation (%)**
Cyprus	2,0	Cyprus	2	0,0%
Hovedstaden	1,7	Denmark	1,9	-10,5%
North Aegean Region	1,2	Greece	1,3	-7,7%
Southern Aegean Region	1,2			-7,7%
Crete	1,3			0,0%
Ionian Islands	1,3			0,0%
Balearic Islands	1,8	Spain	1,9	-5,3%
Canary Islands	1,7			-10,5%
Åland Islands	2,0	Finland	1,9	5,3%
Corsica	n/a	France	n/a	-
Northern & Western	2,3	Ireland	2,1	9,5%
Southern	2,3			9,5%
Eastern & Midland	1,9			-9,5%
Sicily	1,4	Italy	1,4	0,0%
Sardinia	1,4			0,0%
Malta	2,3	Malta	2,3	0,0%
Azores	n/a	Portugal	n/a	-
Madeira	n/a			-
Småland and the islands	1,9	Sweden	1,7	11,8%

5.9 Self-Reported Unmet Needs for Medical Examination

5.9.1 EU Overview

As shown in Figure 23, where an EU overview across all the NUTS2 regions related to the indicator ´Self-Reported Unmet Needs for Medical Examination ´ is provided, it can noticed that the Greek Islands are the most vulnerable island regions, where the numbers are: North Aegean Region (Βόρειο Αιγαίο – 8,6%), Southern Aegean (Νότιο Αιγαίο – 5,7%), and Crete (4,3%). According to the EU overview, the regions with the lowest rates related to the indicator are Malta and the Nordic Regions of Småland med öarna and Åland, where all of them report to have 0% unmet needs for medical examination.

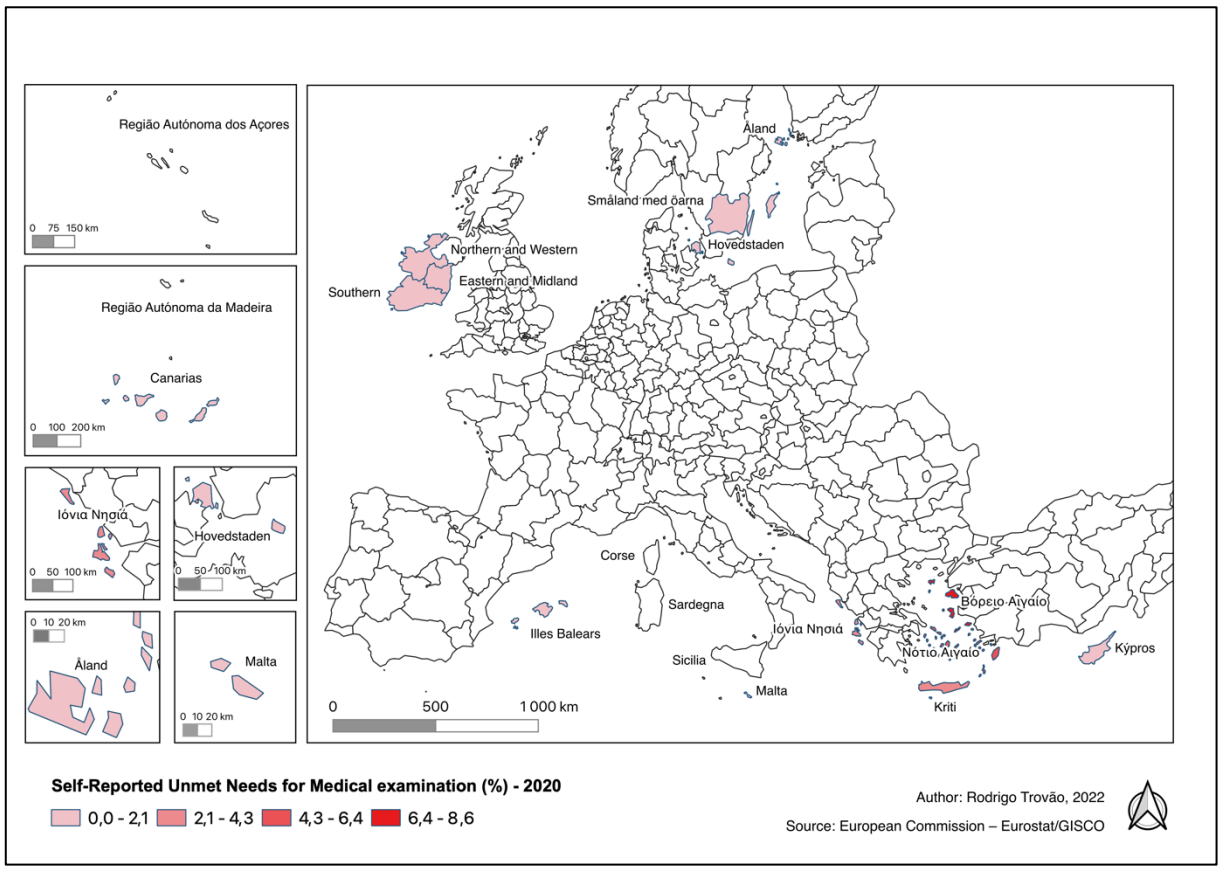

Figure 23 - Self-Reported Unmet Needs for Medical Examination - EU Map Overview

Note - Non-available data for the following NUTS2 Regions: Sicily, Sardinia, Azores, Madeira, and Corse.

5.9.2 3-Year Evolution in Each NUTS2 Region

Considering the results for the present indicator across all the NUTS2 for a three-year time horizon (2018-2020), some aspects that would go undetected if it was only considered the year of 2020, can be detected. As shown in Figure 24, while the top 3 critical regions in 2020 were the North Aegean Region (Βόρειο Αιγαίο), Southern Aegean (Νότιο Αιγαίο), and Crete, in 2018, the 3 regions with high numbers related to the present indicator were the same, but with the Ionian Islands region as the third worst instead of Crete. Between 2018 and 2020, the numbers tend to have dropped in the following NUTS 2 Regions: North Aegean Region, Southern Aegean, Cyprus, and Eastern & Midland. On the other side, there were some regions where the situation in 2019 appeared to be worse when compared to 2018. Between 2018 and 2019, regions such as the Ionian Islands and Southern (Ireland) saw their rates of self-reported unmet needs for medical examination increase. Furthermore, the numbers in 2020 were even worse in some regions in comparison to that same year in 2019. Examples of this are the following regions: Hovedstaden, Canary Islands, and the Balearic Islands.

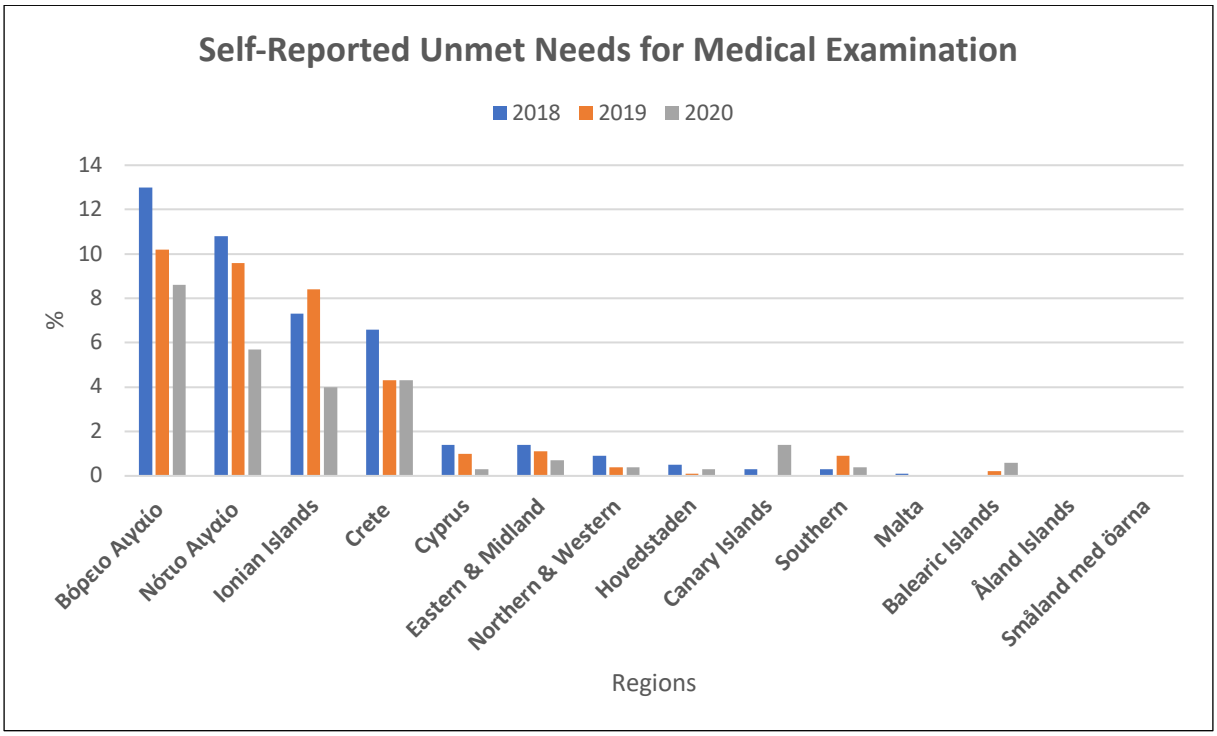

Figure 24 - Self-Reported Unmet Needs for Medical Examination In Each NUTS2 Region

5.9.3 Comparison to the Matching Country Average Value

Regarding the variation between the NUTS 2 regions and their matching countries average value on the indicator ´Self-Reported Unmet Needs for Medical Examination´, through Table 14 some different situations may be observed. The variation between such territories for 2020, was higher in the following regions: Hovedstaden (50,0%), North Aegean Region (Βόρειο Αιγαίο – 45,8%), and Eastern & Midland (16,7%). Such results reveal that the rates of people in this critical situation tend to be higher in island regions when compared to the rates associated with the respective countries. On the other hand, the following regions reveal a better performance compared to their associated country/member state: the Ionian Islands, Northern & Western, and Southern.

Table 14 - Self-Reported Unmet Needs for Medical Examination - Variation Compared to the Country Avg. Value

Self-Reported Unmet Needs for Medical examination (2020)				
NUTS 2 Region	**%**	**Member State**	**%**	**Variation (%)**
Cyprus	0,3	Cyprus	0,3	0,0%
Hovedstaden	0,3	Denmark	0,2	50,0%
North Aegean Region	8,6	Greece	5,9	45,8%
Southern Aegean Region	5,7			-3,4%
Crete	4,3			-27,1%
Ionian Islands	4,0			-32,2%
Balearic Islands	0,6	Spain	0	-
Canary Islands	1,4			-
Åland Islands	0,0	Finland	0	-
Corsica	n/a	France	n/a	-
Northern & Western	0,4	Ireland	0,6	-33,3%
Southern	0,4			-33,3%
Eastern & Midland	0,7			16,7%
Sicily	n/a	Italy	n/a	-
Sardinia	n/a			-
Malta	0,0	Malta	0	-
Azores	n/a	Portugal	n/a	-
Madeira	n/a			-
Småland and the islands	0,0	Sweden	0	-

5.10 Cooling and Heating Degree Days

5.10.1 EU Overview

As shown in Figure 25, where an EU overview across all the NUTS2 regions related to the indicator ´Cooling Degree Days´ is provided, it can noticed that the following regions are the ones with higher amounts of energy needed to cool the buildings, where the numbers are: Cyprus (802,5), Malta (672,3), and Southern Aegean (Νότιο Αιγαίο - 654,6). According to the EU overview, the regions with the lowest numbers related to the indicator, and so fewer needs for cooling the buildings are: Southern, Northern & Western, and Aland.

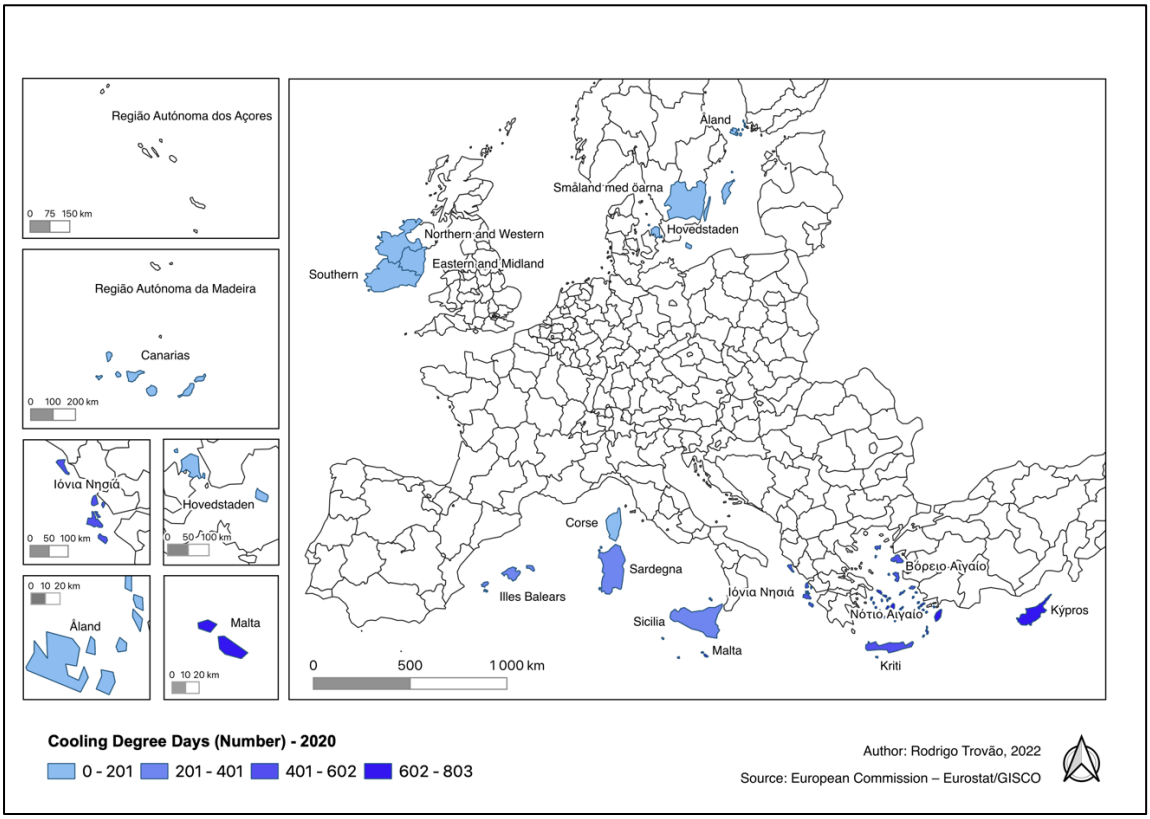

Figure 25 - Cooling Degree Days - EU Map Overview

Note - Non-available data for the following NUTS2 Regions: Azores and Madeira.

Furthermore, as shown Figure 26, where an EU overview across all the NUTS2 regions related to the indicator ´Heating Degree Days´ is provided, it can noticed that the following regions are the ones with large needs of energy needed to heat the buildings, where the numbers are: Aland (3400,8), Småland med öarna (3303,4), and Hovedstaden (2842,2). According to the EU overview, the regions with the lowest numbers related to the indicator, and so fewer needs for heating the buildings are: the Canary Islands, Malta, and Southern Aegean (Νότιο Αιγαίο).

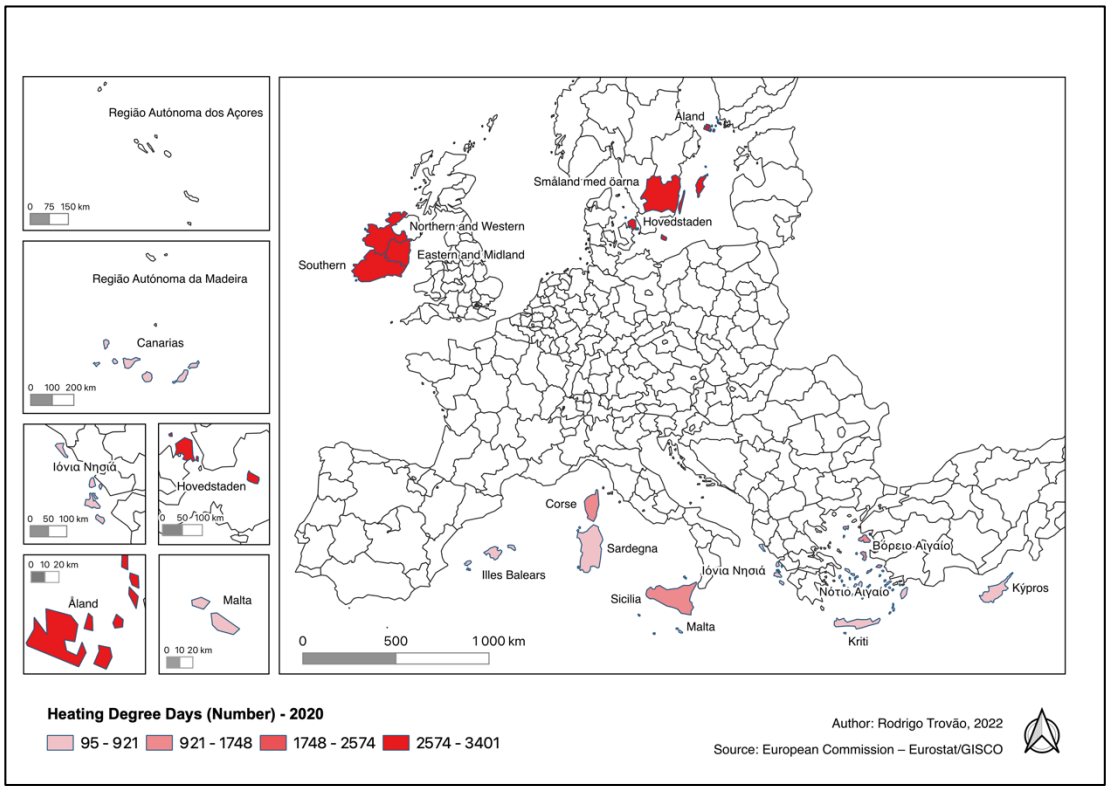

Figure 26 - Heating Degree Days - EU Map Overview

Note - Non-available data for the following NUTS2 Regions: Azores and Madeira.

5.10.2 Comparison to the Matching Country Average Value

Concerning the variation between the NUTS 2 regions and their matching countries average value on the indicator ΄Cooling Degree Days΄, through Table 15 there are some different situations that can be explored. The variation between such territories for 2020 was higher in the following regions: Southern Aegean (Νότιο Αιγαίο), Sicily, and North Aegean Region (Βόρειο Αιγαίο). Such results reveal that in these specific island regions, there are the highest needs of energy to cool down the buildings compared to their countries, where the needs are lower. Furthermore, it can concluded that the given regions have a warmer climate than their associated countries.

Table 15 - Cooling Degree Days - Variation Compared to the Country Avg. Value

Cooling Degree Days by NUTS Region - Annual Data (2020)				
NUTS 2 Region	Number	Member State	Number	Variation (%)
Cyprus	802,5	Cyprus	802,53	0,0%
Hovedstaden	0,3	Denmark	0,58	-50,0%
North Aegean Region	499,3	Greece	344,93	44,7%
Southern Aegean Region	654,6			89,8%
Crete	487,0			41,2%
Ionian Islands	470,9			36,5%
Balearic Islands	398,8	Spain	279,47	42,7%
Canary Islands	198,2			-29,1%
Åland Islands	0,0	Finland	0,42	-100,0%
Corsica	180,1	France	76,37	135,8%
Northern & Western	0,0	Ireland	0	-
Southern	0,0			-
Eastern & Midland	0,0			-
Sicily	363,9	Italy	241,55	50,6%
Sardinia	329,7			36,5%
Malta	672,3	Malta	672,27	0,0%
Azores	n/a	Portugal	266,79	-
Madeira	n/a			-
Småland and the islands	0,0	Sweden	0,08	-87,5%

In regards to the variation between the NUTS 2 regions and their matching countries' average value on the indicator ΄Heating Degree Days΄, through Table 16, there are some different situations that can be explored. Although it was quite insignificant, the variation between such territories for 2020 was higher in the following regions: Eastern & Midland and Northern & Western. Such results reveal that on these specific island regions, when compared to their associated countries, there are highest needs of energy for heating the buildings. Furthermore, it can be concluded that regions like the Canary Islands, Southern Aegean (Νότιο Αιγαίο), and

the Balearic Islands tend to have fewer heating degree days, revealing that these regions have a milder climate than their associated countries.

Table 16 - Heating Degree Days - Variation Compared to the Country Avg. Value

Heating Degree Days by NUTS Region - Annual Data (2020)				
NUTS 2 Region	Number	Member State	Number	Variation (%)
Cyprus	630,5	Cyprus	630,45	0,0%
Hovedstaden	2842,2	Denmark	2920,71	-2,7%
North Aegean Region	999,7	Greece	1489,06	-32,9%
Southern Aegean Region	500,9			-66,4%
Crete	875,4			-41,2%
Ionian Islands	863,1			-42,0%
Balearic Islands	642,7	Spain	1553,94	-58,6%
Canary Islands	94,7			-93,9%
Åland Islands	3400,8	Finland	4871,03	-30,2%
Corsica	1278,6	France	2037,95	-37,3%
Northern & Western	2833,5	Ireland	2744,36	3,2%
Southern	2621,3			-4,5%
Eastern & Midland	2837,9			3,4%
Sicily	1013,0	Italy	1750,4	-42,1%
Sardinia	911,5			-47,9%
Malta	401,9	Malta	401,93	0,0%
Azores	n/a	Portugal	1007,58	-
Madeira	n/a			-
Småland and the islands	3303,4	Sweden	4592,94	-28,1%

5.11 Unemployment Rate

5.11.1 EU Overview

As shown in Figure 27, where an EU overview related to the indicator ´Unemployment Rate´ is provided across the NUTS2 island regions, it can be noticed that the region with the highest rates of unemployment is relative to the Canary Islands (22,6%). Both the Italian region of Sicily (17,9%) and the Greek island of Crete (17,3%) were revealed to be very vulnerable in terms of unemployment too. The regions with the lowest rates related to the indicator are: Malta (4,3%), Northern & Western (4,9%), and Hovedstaden (5,7%).

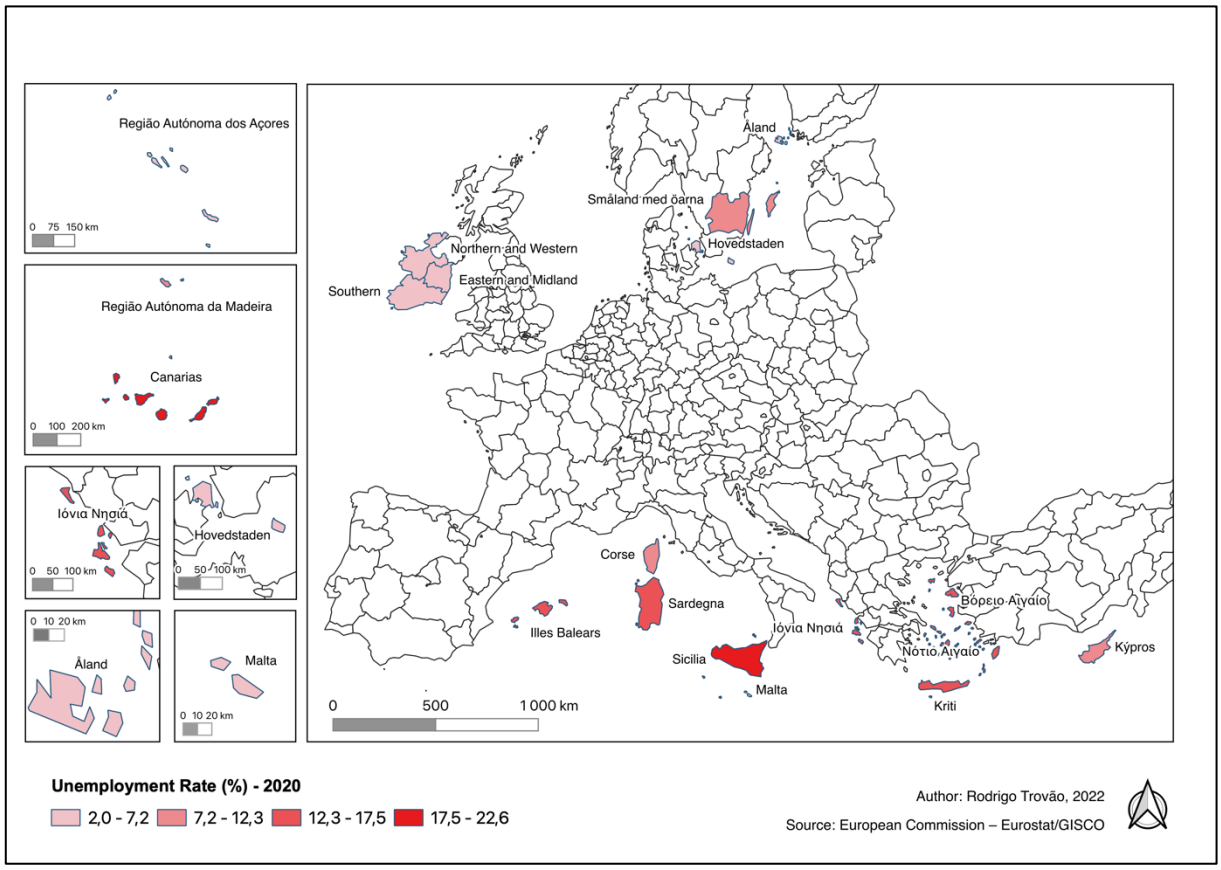

Figure 27 – Unemployment Rate – EU Map Overview

5.11.2 3-Year Evolution in Each NUTS2 Region

Considering the results for the present indicator across all the NUTS2 for a three-year time horizon (2018-2020), some aspects that would go undetected if it was only considered the year of 2020, can be detected. As shown in Figure 27, while the top 3 critical regions in 2020 were the Canary Islands, Sicily, and Crete, in 2018, the 3 regions with the highest numbers related to the indicator ´Unemployment Rate´ were the following ones: North Aegean Region (Βόρειο Αιγαίο), Sicily, and the Canary Islands. It can be concluded that the rates in the North Aegean Region have been dropping over the past few years. Besides this region, between 2018 and 2020, the numbers tend to have dropped too in the following NUTS 2 Regions: Sicily, Sardinia, and the Azores. On the other side, there were some regions where the situation in 2019 appeared to be worse when compared to 2018. Between 2018 and 2019, regions such as the Balearic Islands, Småland med öarna, and Corse saw the rates related to this indicator increase.

Furthermore, the numbers in 2020 were even worse in some regions in comparison to that same year in 2019. All the regions except the North Aegean Region (Βόρειο Αιγαίο), Sicily,

Sardinia, and the Azores saw their 2020 numbers increase compared to 2019. Such results may be related to the Covid-19 pandemic crisis.

Finally, while the regions with the lowest rates related to such indicator in 2018 were Hovedstaden, Corse, and Malta, in 2020, the regions were as follows: Hovedstaden, Northern & Western, and Malta.

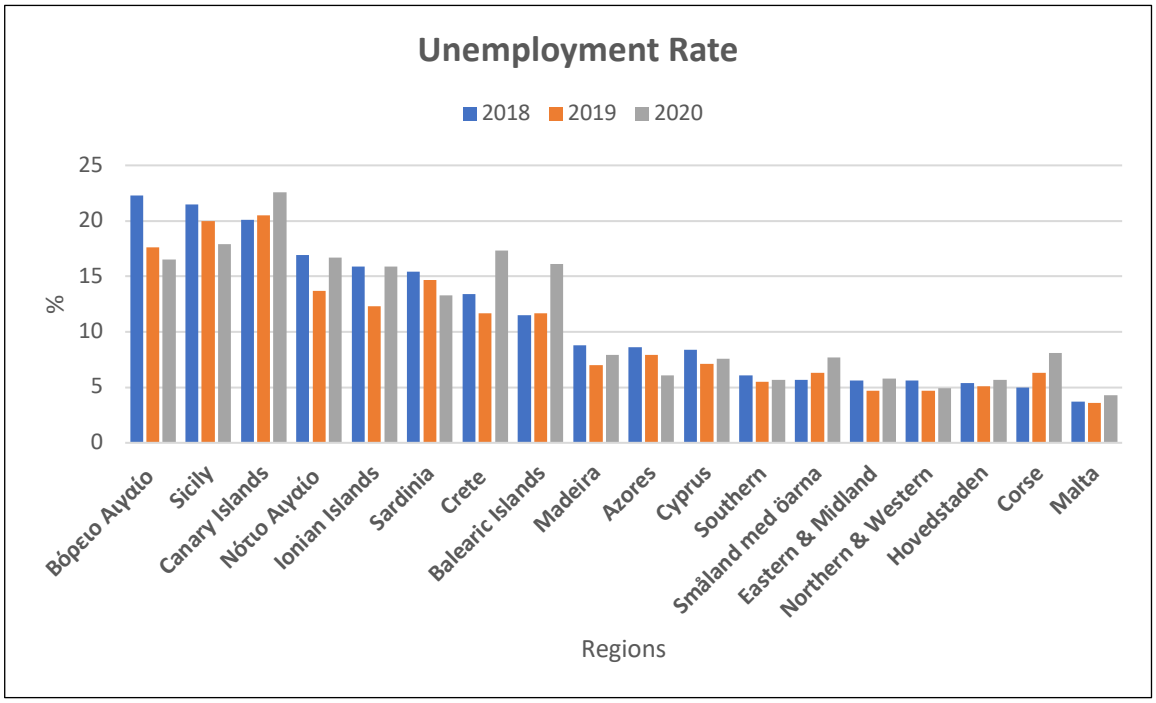

Figure 28 - Unemployment Rate in Each NUTS2 Region

5.11.3 Comparison to the Matching Country Average Value

Regarding the variation between the NUTS 2 regions and their matching countries' average value on the indicator ´Unemployment Rate by NUTS2 Regions´, through Table 17, there are some different situations that can be explored. The variation between such territories for 2020 was higher in the following regions: Sicily (94,6%), Canary Islands (45,8%), and Sardinia (44,6%). Such results reveal that unemployment rates tend to be higher in these island regions than in their respective countries. In contrast, the Italian and Spanish Island Regions seem to be in a very worst condition. On the other hand, the following regions reveal to have lower unemployment rates when compared to their countries: Småland med öarna, Azores, and Northern & Western.

Table 17 - Unemployment Rates by NUTS 2 regions - Variation Compared to the Country Avg. Value

Unemployment Rate (2020)				
NUTS 2 Region	**%**	**Member State**	**%**	**Variation (%)**
Cyprus	7,6	Cyprus	7,6	0,0%
Hovedstaden	5,7	Denmark	5,6	1,8%
North Aegean Region	16,5	Greece	16,3	1,2%
Southern Aegean Region	16,7			2,5%
Crete	17,3			6,1%
Ionian Islands	15,9			-2,5%
Balearic Islands	16,1	Spain	15,5	3,9%
Canary Islands	22,6			45,8%
Åland Islands	n/a	Finland	7,8	n/a
Corsica	8,1	France	8	1,3%
Northern & Western	4,9	Ireland	5,7	-14,0%
Southern	5,7			0,0%
Eastern & Midland	5,8			1,8%
Sicily	17,9	Italy	9,2	94,6%
Sardinia	13,3			44,6%
Malta	4,3	Malta	4,3	0,0%
Azores	6,1	Portugal	6,9	-11,6%
Madeira	7,9			14,5%
Småland and the islands	7,7	Sweden	8,3	-7,2%

5.12 Overall Discussion

5.12.1 Income & Unemployment vs. Poverty Rates

Through an analysis of the results regarding the indicator ´Unemployment Rate´, as shown earlier in this chapter, the NUTS2 regions with high rates related to this indicator are the Canary Islands, Sicily, and Crete. As presented earlier, the indicator ´Income Quintile Share Ratio S80/S20´ shows the inequality of income distribution. The regions with high rates on this indicator and so, the regions with greater inequality in the distribution of disposable income are the Canary Islands, Sardinia, and Sicily. In this scenario, a significant relation seems to exist between these different indicators, suggesting a greater socio-economic vulnerability in the population of both the Canary Islands and Sicily. Furthermore, regarding the indicator ´At Risk of Poverty Rate´, which explores the share of people where the equivalized disposable income, after social transfers, is below the at-risk of poverty threshold, the regions with highest rates were Sicily, Sardinia, and Northern & Western. It might be concluded that the Italian regions, being the main hotspots, could represent the existence of an energy poverty vulnerability condition from a socio-economic perspective. On the other side, Nordic territories such as the Hovedstaden region may not be as susceptible to the existence of an energy poverty condition. This specific region presents low unemployment and at risk of poverty rates, together with high annual income levels, compared to the rates associated with its matching country (Denmark).

5.12.2 Climate vs. Material and Social Deprivation Rates

Regarding the indicator ´Cooling Degree Days´, the Greek Island Regions tend to have higher energy needs to cool the buildings (air conditioning). Contrasting with the Material and Social Deprivation Rate, where the rates are higher too, the Greek population on these islands may be facing a situation where they cannot keep their houses comfortably cool in summer, leading to discomfort related to domestic energy poverty. Cyprus, Malta, and the Italian Regions also seem to present summer vulnerability, expressing that a relation between climate indexes (CDD and HDD) and EU-SILC indicators may be essential to express energy poverty situations, in contrast to other major EP indicators. On the other hand, although the Åland region has large energy needs for heating in the winter, energy poverty may not be so relevant for this region, where the material and social deprivation rate tends to be lower when compared to other regions. The obtained results regarding these two indicators agree with some energy poverty indexes, such as “The European Domestic Energy Poverty Index (EDEPI)” developed by OpenExp [59], where the rates of energy poverty are lower in the Nordic Regions.

5.12.3 Deprivation Rate & Work-Intensity vs Unemployment

In addition, both the Canary Islands and the Greek NUTS2 regions revealed to have high rates on the indicator ´Severe Material Deprivation Rate´. Concerning the rates of ´People living in households with very low work intensity´, which can provide an overview of the economic vulnerability of a given household, the numbers in the Greek and Canary Islands regions revealed to be higher too. The unemployment rates also tend to be higher in these regions. Low working hours over significant unemployment numbers may result in fewer living resources and greater deprivation. This could potentially suggest the inability to pay for adequate energy services, for example, indicating that the population in these regions could be exposed to domestic energy poverty vulnerability. On the other side, the Swedish region Småland med öarna (Smaland and the Islands) might be less likely to present energy poverty vulnerability, where the rates associated with these indicators are lower.

5.12.4 Risk of Poverty vs. Material Deprivation Rates

The rates relative to the indicator ´Severe Material Deprivation Rate´ revealed to be higher in the Canary Islands and the Portuguese regions of Azores and Madeira. In contrast, to the EU overview on the indicator ´People at Risk of Poverty or Social Exclusion´ these same regions proved to be very vulnerable too. Such results may reveal an energy poverty problem/condition where the population could not afford a certain good or service, like the ability to keep the home adequately warm or the capacity to face unexpected expenses at a household level related to some extra-utility bills. Once again, the Nordic regions, specifically, Hovedstaden and Småland med öarna (Smaland and the Islands), proved to be less likely to present energy poverty vulnerability, where the rates regarding such indicators are low.

6

CONCLUSIONS

The main motivation for carrying out this work was to contribute to further recognize energy poverty problem and supporting its eradication around the European Union, with some particular focus on the EU Island Regions. Defined as a state where energy-poor households experience inadequate levels of essential energy services, energy poverty is a significant societal challenge in the European Union, affecting millions of people and resulting in negative consequences for the health and wellbeing of the population. By tackling energy poverty, studies like the present one may contribute with some valuable insights for the development of tailored regional policy to eradicate energy poverty in the EU islands, conducting to an economic boost leading to growth in the European Union. The United Nations Sustainable Development Goals 1 and 7 set the priority on this multidimensional concept by ending poverty in all its forms everywhere and ensuring access to affordable, reliable, sustainable, and modern energy for all citizens [77]. By detecting this type of scenarios, it might be possible to find a more prosperous and equitable European Union.

It should be noted that the development of this work was only possible due to the extensive literature review on the subject and close contact with experts with great know-how in the area. Despite having a recent strong policy interest, this problem is not a new one. The main innovative aspect of this study was to extend the assessment of energy poverty to the EU Islands, which has never been studied in depth.

The results seem to agree with European indexes developed by some research institutions, such as the European Energy Poverty Index (EEPI) produced by OpenExp, where Southern European regions are more exposed to severe energy poverty conditions. The Italian regions (Sardinia and Sicily), as well as the Portuguese regions (Azores and Madeira), and the Canary Islands were revealed to be the regions with the lowest performance in many of the indicators, thus confirming the possibility of the existence of a more accentuated condition of energy poverty. Such results have a special incidence on the indicators: “People at Risk of Poverty or Social Exclusion” and “At Risk of Poverty Rate”. More critically, they also revealed themselves to be the territories where the island rates are more accentuated since the values in these island regions are higher when compared to their matching countries' average values. Additionally,

Greek Island Regions prove to be vulnerable when assessing indicators related to material and social deprivation rates, where the related rates are more extreme compared to the other regions.

6.1 Future Research

Despite all this, there is still considerable work to be done to deep assess the existence of energy poverty on the islands of the European Union. During the development of this study, several difficulties were experienced, where one of the main weaknesses was the significant lack of data in some regions. Indeed, it was initially planned to study the territories with the most disaggregated data possible, that is, to explore the NUTS Level 3 Regions. However, due to lack of data at EU wide level, this became impossible to study. Thus, the focus of this study ended up being extended to the NUTS Level 2 Regions by exploring indicators mentioned in energy poverty literature that could potentially reveal the presence or absence of energy poverty in the considered islands regions. In total, a series of 19 NUTS2 Island Regions were considered, with 13 potential energy poverty indicators being selected. In an attempt to provide a major energy poverty vulnerability screening, an overall discussion was provided, where a relation between different indicators was made to relate some of the results obtained.

On the other hand, one of the main suggestions after the development of this work is to establish energy poverty indicators more specific to the islands of the European Union. That is, to obtain a more certain perspective on the existence of energy poverty, it would be interesting to extend the surveys and reports to these territories as well. EU-SILC target variables such as the "Ability to keep home adequately warm" and the "arrears on utility bills", considered by EPOV as primary indicators that should be considered to identify energy poverty, should be extended to NUTS 2 or NUTS 3 regions, to get a more specific and disaggregated perception of the existence of this type of situations, and to be able to act in more regional scope. It would also be very interesting to have data on some secondary indicators, such as the consensual-based ones: "Dwelling comfortably cool in summer/winter time", and "Share of population with leak, damp or rot in their dwelling".

Given the fact that in this work mostly socio-economic and climatic data were analysed, it would also be interesting to explore indicators associated with energy prices and consumption, as well as buildings energy certification and data related to the quality of buildings, to explore this phenomenon in other dimensions. In addition, it would also be interesting to explore the influence of seasonality in the islands dependent on the influx of tourists, and how this condition can influence poverty rates. Thus, it would be possible to make an even more exhaustive and comprehensive energy poverty assessment.

Concluding, through joint efforts with the establishment of synergies between national and regional authorities, governmental bodies, the research community, health and social institutions, non-governmental organizations, and interested players in the public domain, it will be possible to contribute to the end of this societal challenge and concern, that is energy poverty. Through this and the development of tailored regional policies, it will be possible to overcome energy poverty and improve the population's well-being in the considered regions.

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ANEXXES

Annex A: Trinomics Database of Relevant Energy Poverty Indicators

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Population at risk of poverty or social exclusion	%	share of people below the poverty threshold or in a situation of severe material deprivation or living in a household with very low work intensity	Supporting	Demographics	2.8
RHPI	-	Regional human poverty index (RHPI) comprising four dimensions: social exclusion, knowledge, a decent standard of living, and a long and healthy life.	Supporting	Demographics	2.2
AROP	%	At risk of poverty or social exclusion rate. Measured as the share of people with an equivalised disposable income (after social transfers) below the at-risk-of-poverty threshold.	Supporting	Demographics	2.3
Population unable to make ends meet	%	Percentage of population unable to make ends meet (source: SILC) [ilc_mdes09]	Supporting	Demographics	2.8
Demographic division of the tenants	Age	Includes the shares of tenants in given demographic categories (preproductive, productive, postproductive). The demographic categories are 0-4. 5-9 etc.	Supporting	Demographics	2.8
Ownership & tenure	%	Breakdown by ownership & tenure among low income households	Supporting	Demographics	2.6
The percentage of under-occupied households	%	Under-occupancy is defined in terms of the 1968 Parker Morris standard and the bedroom standard which gives a minimum floor area for a home depending upon the number of occupants. The calculated standard for the household is then compared with the actual number of bedrooms available for its sole use.	Supporting	Demographics	2.5
Tenure status	Qualitative	Tenure status	Supporting	Demographics	2.1
Proportion of children, working age adults and pensioners living in households with low incomes	Number & %	It consists of the percentages of children, working-age adults and pensioners living in households with equivalised income below 60 per cent of median (before housing costs). Net equivalised income before housing costs (BHC) consists of income from all sources net of National Insurance Contributions, Income Tax, Council Tax, private/occupational pension contributions, child maintenance payments, parental contributions to students living away from home, and student loan repayments.	Supporting	Demographics	2.6
Elder population (main tenant above 65)	Number	Reflects the share of dwellings with predominant retired tenants. The characteristic is described through the age of the tenant (above 65).	Supporting	Demographics	2.8
Household type (family composition)	Qualitative	A common classification was developed by Eurostat constructed by reference to the numbers of adult members, their age and gender, and the numbers of dependent children living with them.	Supporting	Demographics	2.5
HH020: Occupier's status	Qualitative	HH020: Occupier's status	Supporting	Demographics	2.8
Customers on prepayment meters for gas and electricity	Number of customers (m)	Customers on prepayment meters for gas and electricity is one indicator to measure the mumber of customers on pre-payment meters	Supporting	Demographics	2.5
DEGURBA (DB100)	Qualitative	The degree of urbanisation of the area where the respondent's household belongs is recorded in the basic SILC variable DB100. The following degrees of urbanisation are considered: DEG1 (Densely populated area); DEG2 (Intermediate density area); DEG3 (Thinly-populated area)	Supporting	Demographics	2.5
HH010: Type of accommodation	Qualitative	HH010: Type of accommodation	Supporting	Demographics	2.7
fuel mix used in production of heat	%	fuel mix used in production of heat	Supporting	Energy demand	2.4
fuel mix of final energy consumption (residential sector)	%	fuel mix of final energy consumption (residential sector)	Supporting	Energy demand	2.5

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
fuel mix of total energy consumption	%	fuel mix of total energy consumption	Supporting	Energy demand	2.5
Final energy consumption per end use per carrier	ktoe	This indicator will reflect the total final energy consumption by end use and per energy carrier. Household energy end use: the use of energy commodities by a household, in order to obtain certain energy service (heating, cooling, how water, etc.). The energy will be divided in different energy carriers: natural gas, fuel oil, coal, electricity, biomass, on-site renewable energy and district heat. Disaggregation of the final energy consumption by carrier will be provided for space heating and domestic hot water.	Supporting	Energy demand	2.6
Theoretical energy use	ktoe	The theoretical energy use is defined as the amount of energy required in a dwelling with an average family using energy for space and water heating, lighting, cooking for an adequate level of warmth. It tends to be much higher than actual energy use due to occupant behaviour, especially for older buildings. This specific consumption is often given for existing dwellings by age bands.	Supporting	Energy demand	2.3
Share of space heating in total residential consumption	%	Share of space heating in total residential consumption	Supporting	Energy demand	2.6
District heating by carrier	ktoe	This indicator will reflect the mix of fuels used for district heating.	Supporting	Energy demand	2.8
Energy consumption for space heating	ktoe	energy consumption for space heating in residential and non-residential sectors	Supporting	Energy demand	2.1
Energy consumption for space cooling	ktoe	This indicator will reflect the total energy consumption for space cooling Space cooling: refers to the use of energy for cooling in a dwelling or building by a refrigeration system and/or unit	Supporting	Energy demand	2.6
Energy consumption for domestic hot water	ktoe	This indicator will reflect the total energy consumption for domestic hot water. Water heating: This energy service is referred to the use of energy to heat water for hot running water, bathing, cleaning and other non-cooking applications. Swimming pool heating is excluded and should be included in other uses.	Supporting	Energy demand	2.6
Rent value	Euro/m2	Average rent value per energy class and building type	Supporting	Income/expenditure	2.3
Average rent value	euro/month	Covers average prices for rental housing. Price average rent € for m2 for rental housing. It also includes the energy costs.	Supporting	Income/expenditure	2.7
Rent growth	%	Annual growth of rent in %, separately for social and private rents	Supporting	Income/expenditure	2.5
Breakdown of rents	%	Percentage of social and private rents	Supporting	Income/expenditure	2.6
energy-related investments for renovation	Euro/m2	Average volume of energy-related investments for renovation	Supporting	Income/expenditure	2.3
Average energy cost savings per retrofit	Eur/kWh	amount of kWh saved on delivered energy, multiplied by respective tariff. Energy price developments need to be taken into account. Reflecting the regulation on cost optimal buildings performance requirements under EPBD, energy priced developments should reflect a period of 30 years (residential buildings)	Supporting	Income/expenditure	2.1
Costs of energy building renovation	€/m²	This indicator will reflect the unit costs of energy buildings renovation according to different level of retrofitting	Supporting	Income/expenditure	2.3
Total volume of investments renovation	Mio EUR/a	This indicator will reflect the total volume of total investments (energy related and non-energy related) in renovation	Supporting	Income/expenditure	2.3
Energy tariffs	Eur/kWh	Energy tariffs (marginal costs, variable component average costs per kWh). Reflects the energy prices per energy carrier for households	Supporting	Income/expenditure	2.6
Average domestic energy prices	EUR	Average domestic energy prices in real terms are used to assess fuel prices	Supporting	Income/expenditure	2.4

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Average District Heating price	EUR/GJ	Average District Heating price	Supporting	Income/expenditure	2.5
Average Annual Gas and Electricity Bills by Payment Method	Pounds	Average Annual Gas and Electricity Bills by Payment Method is one indicator to measure the mumber of customers on pre-payment meters	Supporting	Income/expenditure	2.5
Share of households expenditures on housing	%	final consumption expenditure of households devoted to housing, water, electricity, gas and other housing fuels	Expenditure-based	Income/expenditure	3.0
% of income spent on heat, power and light	%	It can be compared to different thresholds: 10-15% is fuel poor, 15-20% is severe fuel poverty and >20% is extreme fuel poverty	Expenditure-based	Income/expenditure	2.6
Actual expenditure on fuel	%	Percentage of income spent on fuel for households in the lowest and highest 30 per cent income groups	Expenditure-based	Income/expenditure	2.8
Energy expenditure greater than 10% of total expenditure	%	Energy expenditure greater than 10% of total expenditure. Where E: energy expenditure (electricity + heating) and D: disposable income	Expenditure-based	Income/expenditure	2.0
Energy expenditure > twice average/mean	%	(DE: Share of expenditure twice as high as mean)	Expenditure-based	Income/expenditure	2.2
Energy expenditure greater than twice the conditional median	%	(DE: Share of expenditure twice as high as median)	Expenditure-based	Income/expenditure	2.2
Energy costs equal or above twice the median relative energy expenditure	%	Energy expenditure equal or above twice the median relative energy expenditure (i.e. share of energy expenses in the total household expenditure). The median is estimated as an average of medians of 2 years.	Expenditure-based	Income/expenditure	2.4
Energy costs are larger than food and non-alcoholic beverage costs	%	Energy costs are larger than its food and non-alcoholic beverage costs	Expenditure-based	Income/expenditure	2.4
Energy costs >= median relative energy expenditure of the 3 lowest income deciles	%	Energy costs equal or above the median relative energy expenditure of the three lowest income deciles	Expenditure-based	Income/expenditure	2.4
Minimum quantities of energy (expenditure) required by household	%	Absolute measure expenditure-based criterion: Households that consume less energy than the minimum required where E: expenditure; m: based on the number of persons in the family (in a range between 1.1 – 2.4 MWh); n: based on the type of dwelling and number of persons in the family.	Expenditure-based	Income/expenditure	1.6
Disposable household income before & after energy expenditure for adequate space heating	EUR/household	average income per household before and after energy expenditure for adequate space heating (theoretical energy demand)	Expenditure-based	Income/expenditure	2.1
Proportion of disposable household income spent on adequate energy for space heating	%	Share of energy expenditure for space heating out of the disposable household income (using theoretical energy demand)	Expenditure-based	Income/expenditure	2.1

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Average energy spending for adequate space heating per household)	EUR/household	average cost of energy consumption for adequate space heating for residential buildings (theoretical energy demand	Expenditure-based	Income/expenditure	2.1
Exact amount of the monthly net income of the household	€	Household Budget survey (HBS) indicator. A household's income is determined through the variable "Exact amount of the monthly net income of the household" (IMPEXAC in Spanish), which is then multiplied by 12 to calculate the annual amount. IMPEXAC does not include extraordinary income (e.g. from lottery, inheritance) but it does include other regularly (but not necessarily monthly) perceived income (bonus pay, income from rented properties e.g. every summer).	Supporting	Income/expenditure	2.5
Disposable income	%	It measures year-on-year (annual) change in real disposable household income. This indicator shows real disposable income and is based on the Real Disposable Income series, using calendar years.	Supporting	Income/expenditure	2.6
MIS (SGBII) Minimum Income Standard	€ , %	Minimum income standard	Supporting	Income/expenditure	2.2
HY020: Household's available income	Euro	HY020: Household's available income	Supporting	Income/expenditure	2.5
Percentage of income spent for energy (or heating)	%	Expenditure on energy services greater or equal to 10% of income.	Expenditure-based	Income/expenditure	2.5
Proportion of annual income of a household allocated into paying energy costs	%	Indicator Household Budget survey (HBS). Expenditures in energy are calculated summing expenses in the category COICOP04.5 (Electricity, gas and other fuel) for the first and (when applicable) second house of the household. Only monetary costs are taken into account, that is, things like firewood is excluded. For electricity and gas concretely, the calculations are made based on the latest payed bill. In accordance with the temporary raising factor, the registered quantity is multiplied by the number of times that such an invoice has been paid in the previous 12 months.	Expenditure-based	Income/expenditure	2.6
% of disposable income used for energy (gas, electricity) expenditure	%	Called "energy quote". By year, by age group, by income group, by size of household, by type of building (rent/bought; standalone/ maisonette/ flat/ etc; energy label A-G)	Expenditure-based	Income/expenditure	2.6
Energy Effort Rate (EET)	%	Percentage of households that spend more than 10% of their income on energy expenses.	Expenditure-based	Income/expenditure	2.4
Energy expenditure >10% of disposable income	%	Energy expenditure greater than 10% of disposable income In RO: assuming the household living with appropriate levels of thermal condition and the corresponding expected consumption	Expenditure-based	Income/expenditure	2.4
Percentage of total expenditures on energy (>10% of income)	%	Energy expenditure is equal or above to 10% of the income	Expenditure-based	Income/expenditure	2.5
More than x% of disposable income spent on energy services	%	If the household spends more than 10% of its disposable income, it is considered poor. If more than 15% it is severely poor. If more than 20% if its extremely poor.	Expenditure-based	Income/expenditure	2.5
Percentage of total income spent on energy costs (>34%)	%	380.000 Hungarian households (8-10 % of households) spent at least 34 % of their income for electricity and gas. According to the experts this percentage represents a threshold of energy poverty	Expenditure-based	Income/expenditure	2.3

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Electricity (5%) and gas expenditure (10%) vs disposable income	%	Electricity expenditure greater than 5% of disposable income and heating/gas expenditure above 10% of disposable income	Expenditure-based	Income/expenditure	2.0
households that need to spend > 10% of income on fuel to heat their home to an adequate standard of warmth	%	Proposed revision to Directive 2002/91/EC, used in the UK. Share of households which spend more than 10% of their income in heating their home to an acceptable standard identified by the WHO (21C in living room and 18C in other occupied rooms)	Expenditure-based	Income/expenditure	2.3
TEE more than twice median	%	Energy Effort Rate more than twice the median, excluding the richest vulnerable households.	Expenditure-based	Income/expenditure	2.5
Percentage of income household spent on heating compared to average % in EU	%	Percentage of income household spent on heating compared to average % in EU	Expenditure-based	Income/expenditure	2.5
% of household budget spent on gas and electricity by households with low incomes	%	The percentage is compared to the national average	Expenditure-based	Income/expenditure	2.4
Low Income High Expenditure Indicator (BRDE)	%	Considers that a household is in a situation of energy poverty if the two conditions of low income and high energy expenditures are met.	Expenditure-based	Income/expenditure	2.5
HCLI EI BHC: High cost, low income equivalised income before housing costs	%	Low Income High Cost approach	Expenditure-based	Income/expenditure	2.2
Households below an "at risk of poverty" threshold AND above-average energy costs	k	Preferred definition of energy poverty in Austria. "Poverty risk" well defined and differs from national poverty line (approx 1066 EUR/month vs. 800/EUR/month welfare guarantee).	Expenditure-based	Income/expenditure	2.4
LIHC: Low income high cost indicator (UK, 2013)	%, n	Measure developed by Professor Hills as a response to the weaknesses of the Fuel Poverty Gap Indicator. Adopted by the UK Government for defining fuel poverty in England only. Individuals and the households they live in (both are tracked) are fuel poor based on two criteria – i) fuel costs above the median level, and ii) net of fuel cost spend, their residual income is below the official poverty line. (60% of median equivalised household income after housing costs)	Expenditure-based	Income/expenditure	2.6
Households in fuel poverty	Absolute number	It measures the number of households in fuel poverty. Households with required fuel costs that are above average (the national median level) are calculated by: 1. Taking required fuel costs for the household from the fuel poverty dataset (the "fuelexpn" variable) 2. Applying the corresponding equivalisation factor for each household. 3. Dividing the required fuel costs by the equivalisation factor to get the equivalised required fuel costs for that particular household. Equivalising effectively increases the bills of single person households, and decreases the bills of multiple person households, with the aim of making them comparable. 4. To calculate the fuel cost threshold, simply take the weighted median of all of these equivalised	Expenditure-based	Income/expenditure	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
		required fuel costs. Half of all households should have "high costs" i.e. above the threshold, and half should have "low costs" i.e. below the threshold.			
% households below the poverty line after energy cost for adequate space heating	% of households	percentage of households that would be left with a disposable income below the poverty line after covering the cost for adequate space heating (theoretical energy demand)	Expenditure-based	Income/expenditure	2.1
(net household income - housing costs - energy costs) > minimum living costs (MIS)	%	Household is considered poor if housing and energy costs are higher than the minimum income standard (MIS), which is the minimum income for different household types that is needed to participate in society. In Dutch this is called 'not-much-but-sufficient budget (NVMT-budget)'	Expenditure-based	Income/expenditure	2.2
SAP rating of households in the lowest 30 per cent of income groups and the average SAP rating	Absolute number	SAP (Standards Procedure Assessment) rating of households in the lowest 30 per cent of income groups and the average SAP rating for England indicates about the energy efficiency (SAP rating) of the housing stock. The Standard Assessment Procedure (SAP) is adopted by Government as the methodology for calculating the energy performance of dwellings. The SAP rating is based upon the energy costs associated with space heating, water heating, cooking and lighting in a dwelling. It is adjusted for floor area so that it is essentially independent of this for a given built form. SAP ratings are expressed on a scale of 1 to 100, with higher numbers contributing to lower energy costs. This indicator is based on SAP05, to allow comparability with previous years. SAP09 data is also now available.	Other energy poverty metric	Income/expenditure	2.4
% of total expenditures on energy for households with expenditures < 40% of median expenditures	%	Percentage of total expenditures on energy for households with expenditures below 40% of the median expenditures	Expenditure-based	Income/expenditure	2.0
Average district heating cost for old buildings compared to average earnings per month	EUR	Average district heating cost for old buildings compared to average earnings per month	Expenditure-based	Income/expenditure	1.9
Weight of household energy products in HICP	%	Weight of household energy products in the Household Index of Consumer Prices	Expenditure-based	Income/expenditure	2.3
MEP extent	Absolute number	households in the lower five deciles of equivalised incomes whose energy expenditures were higher than acceptable threshold	Expenditure-based	Income/expenditure	2.3
MEP depth	EUR	energy poverty gap (in EUR) above "acceptable" energy bill	Expenditure-based	Income/expenditure	2.3
HEP extent	Number	Hidden energy poverty: households whose energy bills are "abnormally low" according to what would be considered adequate according to the number of people in the household and the size of the dwelling	Expenditure-based	Income/expenditure	2.3
HEP depth	EUR	Hidden energy poverty: energy poverty gap (in EUR) below "acceptable" energy bill	Expenditure-based	Income/expenditure	2.3
Fuel poverty gap indicator	Absolute number	The fuel poverty gap is the additional spend required between actual spending and necessary spend to ensure a household is no longer fuel poor. In other words, the extent to which assessed energy needs of fuel poor households exceed the threshold for reasonable costs. The threshold is set at 10%.	Expenditure-based	Income/expenditure	2.5
Average Level of Customer Debt	Number (Pounds)	Average Level of Customer Debt is used to estimate fuel debt. 'Debt' refers either to customers who have a PPM set to collect a debt or customers who are on a rescheduled debt repayment programme due to last longer than 91 days/13 weeks. Direct debit customers would only fall within this definition if they have specifically set up a direct debit in order to repay a debt	Outcome-based	Outcomes	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Amounts owed by gas customers on a debt payment arrangement (as in the final quarter of each year)	% of customers in debt	Amounts owed by gas customers on a debt payment arrangement (as in the final quarter of each year) are used to estimate fuel debt	Outcome-based	Outcomes	2.6
Arrears on utility bills	%	percentage of households/persons out of the total population who are in the state of arrears on utility bills, expressing the enforced inability to pay their utility bills on time	Consensual-based	Outcomes	3.0
Disconnection rates	%, n days	Number (share) of households experiencing disconnection of power/gas/district heat due to not paying the bills. Average number of days/a with disconnection	Outcome-based	Outcomes	2.9
customers disconnected due to debt	Absolute number	Number of customers disconnected due to debt are used to estimate fuel debt	Outcome-based	Outcomes	2.6
disconnections from gas or electricity supply	Absolute number	Used to calculate consequences of poverty related to energy. Number of disconnections of electricity supply due to non-payment of electricity bills (households consumers)	Outcome-based	Outcomes	2.8
Self-disconnection	%	Self-disconnection is usually assessed among pre-payment customers. The indicator measures the share of houses that self-disconnect one or more than one time among prepayment energy customers	Outcome-based	Outcomes	2.0
inhabitants unable to keep home adequately warm (HH050)	%	share of the total population who perceive are not able to keep their home adequately warm	Consensual-based	Outcomes	3.0
Cold Indicator	%	Relies on testimonials about how warm people feel in their households.	Consensual-based	Outcomes	2.5
inhabitants who are living in a dwelling not comfortably cool in summer	%	share of the total population who live in a dwelling not comfortably cool in summer	Consensual-based	Outcomes	2.9
Households that cannot afford enough fuel for water heating and cooking needs	%	Share of Households that feel cannot afford enough fuel for water heating and cooking needs	Consensual-based	Outcomes	2.1
Can you afford to keep your house at an adequate temperature during the cold months?	Open answer	One of the three indicators on Spanish Survey on Income and Living Conditions (SILC) which is therefore carried out with harmonised criteria to allow for comparability.	Consensual-based	Outcomes	2.5
Excess winter mortality/deaths	%	expected deaths in winter are higher than the rest of the year % of excess deaths in winter compared with the non-winter months (based on the formula: EWD = {[winter deaths (Dec-Mar)]-0.5[Non-winter deaths (Aug-Nov, Apr-Jul)]}/(Average of non-winter deaths)	Outcome-based	Outcomes	2.8
Excess Winter Deaths	Absolute number	Excess Winter Deaths in countries of the UK. Excess winter deaths are defined as the difference between the number of deaths which occurred in winter (December to March), and the average number of deaths during the preceding and subsequent four month periods (August to November and April to July). The temperature data used for this indicator relates to the average temperature during the months of December to March and is consistent with the temperature data used in the indicator on cold weather payments.	Outcome-based	Outcomes	2.8
Additional death rate in winter (tasa de	Absolute number	statistical information that allows one to assess the effects of energy poverty on health and the benefits in terms of public health that can be obtained by reducing or eradicating such. It calculates the number of	Outcome-based	Outcomes	2.5

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
mortalidad adicional de invierno (TMAI))		premature deaths of old people that could have been avoided if energy poverty would not exist. In the period 1997-2010 Spain has calculated this following the method of Johnson & Griffiths (2003) and Healy (2004). This consists of comparing the amount of deaths in the months december - march with the number in the four previous and posterior months, all to obtain a total number of additional deaths and the percentage that corresponds to that difference.			
Estimated number of vulnerable households in fuel poverty	Number of households (m)	It measures the number of households in fuel poverty. Estimates of fuel poverty at aggregate UK level should be treated as a broad approximation as different data collection periods and methods are used across countries.	Outcome-based	Outcomes	2.6
Composite indicator using Eurostat data	Absolute number	Assuming the 3 Eurostat metrics ("People living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames of floor" (M1); "Inability to keep home adequately warm" (M2); "Arrears on utility bills" (M3)) , it is possible to examine the fuel poverty making use of a simple composite measurement multiplying each by a weight (Healy & Clinch, 2002), whose sum is 100%.	Consensual-based	Outcomes	2.5
Delay from multi-apartment communities to switch on heating	Number of days	Delay from multi-apartment communities to switch on heating The delay between the national legislation about the start of the heating season (temp <10 degrees for 3 consecutive days) and multi-apartment communities switching on the heating. The delay is based on majority vote in the multi-apartment community	Other energy poverty metric	Outcomes	1.9
vulnerable consumers contacted by DSO due to nonpayment	Absolute number	Number of vulnerable households informed by the DSO regarding the urgency to get a new supplier or possibility of supply of last resort in case of nonpayment, prior to disconnection.	Other energy poverty metric	Outcomes	1.9
What temperature is your household at during the day when you are home and the heating is on?	number	The Encuesta de Hogares y Medio Ambiente (EHM) is the variable module of the European Households Survey, whose purpose was to collect information about the habits, consumption patterns and attitutes of households with regards to the environment (energy and water savings, waste separation) and investigate the households' equipment and use thereof. Information compiled with regards to heating and the temperature inside the house is relevant for energy poverty.	Consensual-based	Outcomes	2.5
changed behaviour with regards to expenses after crisis	Open answer	Since the economic crisis, in order to save money, has your household changed behavior with regards to food, transport, clothing, vacation, medical treatments, energy expenses or energy supply control? Los Barómetros del Centro de Investigationes Sociologicas (CIS) (the Barometer of the Center for Sociological Research) measures changes in public opinion and political attitudes (particularly, the intended vote) are measured based on some questions. The sample is 2500 people.	Consensual-based	Outcomes	2.5
MEPI	Index	Multidimensional Energy Poverty Index (MEPI) – focuses on the deprivation of access to modern energy services. It captures both the incidence and intensity of energy poverty	Outcome-based	Outcomes	2.3
Building stock decomposition by building or dwelling type	Mm^2	This indicator will reflect the number of buildings/ building units and the floor areas on the building stock by building type	Supporting	Physical infrastructure	2.8
Building stock decomposition by size	Mm^2	This indicator will reflect the distribution of the household's size. The unit will be number of dwellings and related floor area (when available)	Supporting	Physical infrastructure	2.8
Building stock decomposition by ownership status	%	This indicator will reflect the share of buildings/building units in the total stock by the ownership status	Supporting	Physical infrastructure	2.8
Building stock decomposition by occupancy level	%	This indicator will reflect the share of buildings/building units in the total stock by the occupancy levels. There is two types of residence: Primary residence and Secondary residence	Supporting	Physical infrastructure	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Breakdown of dwelling stock by energy used for space heating	%	Breakdown of dwelling stock by energy used for space heating	Supporting	Physical infrastructure	2.6
Disaggregation of buildings according to heating device capacity	Absolute number	This indicator will reflect the number of the building/buildings units according to the heating device capacity. Following the EPBD provisions on inspections of heating systems, the heating devices will be disaggregated according to their capacity, in the ranges as follows: <20kW; >100 kW.	Supporting	Physical infrastructure	2.0
Breakdown of dwellings according to heating systems	%	Breakdown of dwellings according to heating systems	Supporting	Physical infrastructure	2.6
Buildings/building units with central steam/hot water space heating system	Absolute number	This indicator will reflect the number of buildings/building units with central steam/hot water space heating system. Central steam/hot water space-heating system: It provides steam or hot water to radiators/convectors or pipes (including under-floor heating) in a dwelling. (Eurostat).	Supporting	Physical infrastructure	2.8
Buildings/building units with a built-in electric system	Absolute number	This indicator will reflect the number of buildings/building units with a built-in electric system. Built - in electric system: A system of electrical resistances (usually as under-floor heating) providing heat to individual rooms; the system is part of the building electrical installation. (Eurostat)	Supporting	Physical infrastructure	2.8
Buildings/building units with heat pumps	Absolute number	This indicator will reflect the number of buildings/building units with heat pumps. Devices that bring heat in the dwelling from the environment using a compressor (mechanical work). Two main types of heat pumps are used in household sector and commercial applications: air-source heat pumps (by far the most common) and ground-source (or geothermal) heat pumps. (Eurostat)	Supporting	Physical infrastructure	2.8
Buildings/building units with condensing boilers	Absolute number	This indicator will reflect the number of buildings/building units with condensing boiler. Condensing boilers are water heaters fuelled by gas, coal, oil or biomass. They achieve a high efficiency (typically greater than 90% on the higher heating value) by using waste heat in fuel gases to pre-heat cold water entering the boiler.	Supporting	Physical infrastructure	2.6
Buildings/building units with conventional boilers	Absolute number	This indicator will reflect the number of buildings/building units with conventional boilers. Conventional boilers are water heaters fuelled by gas, coal, oil or biomass.	Supporting	Physical infrastructure	2.6
Buildings/building units with combi boilers	Absolute number	This indicator will reflect the number of buildings/building units with combi boilers. A combi boiler provides heated water for both space heating and domestic hot water heating.	Supporting	Physical infrastructure	2.6
Disaggregation of type of glazing	Absolute number	This indicator will reflect the number of buildings/buildings units by type of the window/glazing. The type of glazing can be as follows: single, double, high performance double, triple and quadruple. The disaggregation will be done per age band and building type.	Supporting	Physical infrastructure	2.3
Disaggregation of type of window frame	Absolute number	This indicator will reflect the number of buildings/buildings units by type of window frame. Type of window frames can be as follows: wooden, plastic, metal or other materials like composites. The disaggregation will be done per age band and building type.	Supporting	Physical infrastructure	2.3
Disaggregation of buildings according to heating system level	Absolute number	This indicator will reflect the number of dwellings served by heating systems. Collection of data on heating system level as follows: individual and collective heating. This indicator will be expressed in %. The collective space heating system is serving more than one dwelling: multiple dwellings in one building (boiler room for the whole building), several buildings, community, district (local, community or district heating plants). An individual space heating system provides heat to a single dwelling. (Eurostat)	Supporting	Physical infrastructure	2.6
Disaggregation of space heating devices	Absolute number	This indicator will reflect the number of buildings/building units using below mentioned energy sources. Heating systems can generate heat using a different number of energy sources such as electricity, natural gas, coal, fuel oil, liquefied petroleum gas, kerosene, biomass and solar thermal energy. (Eurostat)	Supporting	Physical infrastructure	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
according to the energy source					
Disaggregation according to space cooling equipment coverage	No. of	This indicator will reflect the number of buildings/building units supplied with air conditioning systems (central or local). Central and local air conditioning systems Equipment used for a space cooling can be divided into two broad categories: central cooling systems or local (room dedicated) cooling systems. Central air conditioning systems have ducts to bring cooled air in the individual rooms of the dwelling. Local air conditioning system: electrically driven individual units that provide cooling to single room of a dwelling (wall air conditioners, split systems). (Eurostat)	Supporting	Physical infrastructure	2.6
Disaggregation of heating system according to the age of the space heating equipment	years	Age of the main heating system of the household	Supporting	Physical infrastructure	2.3
Buildings/building units with mechanical ventilation (with heat recovery)	Absolute number	This indicator will reflect the number of buildings/building units with mechanical ventilation (with heat recovery) Partly ditto as above. This is always balanced ventilation; it means there are both mechanical supply and exhaust of ventilation and/or heating air. Part of the heat from the exhaust air is recovered in a heat exchanger.	Supporting	Physical infrastructure	2.3
Building stock decomposition by climatic zone	Absolute number	This indicator will reflect the number of buildings/ building units on the building stock by the climatic zones defined at national level. Climatic zones are usually represented as homogenous zones in terms of climate-based on heating or cooling degree-days; climatic areas are defined in national in thermal regulations. Climatic zones can be defined at EU level	Supporting	Physical infrastructure	2.4
Building stock decomposition by construction period	Mm^2	This indicator will reflect the number of buildings/ building units and the floor areas on the building stock by building type and by construction period	Supporting	Physical infrastructure	2.8
Average floor area per person	m2 per person	Indicator of the living comfort, describes average floor area per person (dweller) according to the type of building in division to family houses and apartment buildings.	Supporting	Physical infrastructure	2.6
DB100: Living area		Degree of urbanisation	Supporting	Physical infrastructure	2.8
Average number of rooms per person	no. of person	This indicator includes average number of rooms per person (dweller) according to the type of building in division to family houses and apartment buildings.	Supporting	Physical infrastructure	2.8
Average performance level reached after renovation	kWh/m^2	This indicator will reflect the average performance level achieved in the refurbished buildings by type of building and type of renovations	Supporting	Physical infrastructure	2.3
Energy performance of households	Classification letters	Poor energy performance: households classified F or G	Supporting	Physical infrastructure	1.9
Average efficiency rate of technical system for space heating	%	average efficiency rate for space heating of all installed systems	Supporting	Physical infrastructure	2.1
Average efficiency rate for space heating	%	This indicator will reflect the average efficiency rate for space heating of all installed systems.	Supporting	Physical infrastructure	2.4
Average energy performance of new construction	kWh/m^2	average energy performance of new construction per building type	Supporting	Physical infrastructure	2.1

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
thermal condition		maximum value of 100 kWh/m2-y. In practise, values of actual specific requirements would be inferred from the construction type and age, taking into account of any energy efficiency interventions made	Supporting	Physical infrastructure	1.9
Average U-value for overall building envelope	W/m2°C	average U-values for overall envelope, which will be provided per age band and building type	Supporting	Physical infrastructure	2.3
Average U-value of doors	W/m2°C	A U-value is a measure of heat loss through a building envelope element or it's also called a heat transfer coefficient. A low U-value indicates a high level of insulation. The unit is W/m2K or W/m2°C. It regards an average U-value of all doors, if possible weighed according to m2 of doors having the same U-value.	Supporting	Physical infrastructure	2.6
Average U-value of external walls	W/m2°C	A U-value is a measure of heat loss through a building envelope element or it's also called a heat transfer coefficient. A low U-value indicates a high level of insulation. The unit is W/m2K or W/m2°C. It regards an average U-value of all doors, if possible weighed according to m2 of doors having the same U-value.	Supporting	Physical infrastructure	2.6
Average U-value of floors	W/m2°C	A U-value is a measure of heat loss through a building envelope element or it's also called a heat transfer coefficient. A low U-value indicates a high level of insulation. The unit is W/m2K or W/m2°C. It regards an average U-value of all doors, if possible weighed according to m2 of doors having the same U-value.	Supporting	Physical infrastructure	2.6
Average U-value of roofs	W/m2°C	A U-value is a measure of heat loss through a building envelope element or it's also called a heat transfer coefficient. A low U-value indicates a high level of insulation. The unit is W/m2K or W/m2°C. It regards an average U-value of all doors, if possible weighed according to m2 of doors having the same U-value.	Supporting	Physical infrastructure	2.6
Average U-value of windows	W/m2°C	Ditto. The U-value is calculated for window pane and frame together.	Supporting	Physical infrastructure	2.6
Air tightness	dm3/s/m2	This indicator will reflect the airtightness values provided by age band and per building type. Airflow through the construction at a given building-to-outside reference pressure, typically at 50 pascal (Q50). The unit is m3/(m2·h) or dm3/s/m2.	Supporting	Physical infrastructure	2.5
Cumulative numbers of gas and electricity transfers	Number of transfers (m)	Cumulative numbers of gas and electricity transfers indicate the number of customers switching supplier	Supporting	Physical infrastructure	2.5
Time series of homes with cavity wall insulation and loft insulation	Absolute number	Time series of homes with cavity wall insulation and loft insulation in Great Britain indicates the number of insulated homes. The estimates for this statistical series are produced by using the 2008 English Housing Survey as a baseline, and then adding known changes from the Carbon Emissions Reduction Target (CERT), the Community Energy Saving Programme (CESP), and Warm Front schemes. This is supplemented with data on house building from Communities & Local Government.	Supporting	Physical infrastructure	2.1
Number of Local Authority-owned dwellings receiving insulation and central heating	Number and Pounds	Dwellings in receipt of more than one type of measure are counted under each category of works, e.g. a dwelling counted as having new insulation installed may be counted again as having central heating installed. Therefore, the dwellings receiving new insulation cannot simply be added to those receiving central heating as an estimate of the number receiving either measure.	Supporting	Physical infrastructure	2.5
Percentage of vulnerable costumers with/without heating installations	%	Without: heating is done mainly using solid fuel	Supporting	Physical infrastructure	1.9
system inefficiencies	Qualitative	Driver (Homes with poor energy efficiency)	Supporting	Physical infrastructure	2.0
high energy costs due to poor thermal performance	Absolute number	the occupied dwelling has poor thermal performance; lack of access to reasonable priced energy sources; lack of an effective / adequate heating system.	Expenditure-based	Physical infrastructure	2.0

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
Household-level fuel poverty indicator	Absolute number	A 'hybrid' approach, integrating both physical and household characteristics. Integrates data from a large household survey (N = 1595) with datasets (including GIS), and is based on the UK's Standard Assessment Procedure(SAP), but making several adjustments to account for household size, electricity consumption, occupancy patterns and up-to-date, local fuel prices. Household data were collected using a questionnaire, based largely on the WZ survey (53 questions including: property information, space and hotwater heating system, energy suppliers and payment methods, levels of insulation, and occupant details).	Other energy poverty metric	Physical infrastructure	2.0
Energy renovation	k,Mm²	This indicator will reflect the number of the buildings and floor area that undergoes annually thermal building renovation	Supporting	Physical infrastructure	2.6
Stock of nZEBs	Absolute number	This indicator will reflect the total number of buildings that meet the nearly Zero-Energy Building (nZEB) standards defined at national level. Each country defines its nZEB standard according to New construction and Building renovation	Supporting	Physical infrastructure	2.6
Wall insulation improved from the original state	%	This indicator will reflect the share of the number of the buildings with an wall insulation inpoved from oridinal state. (As defined in EPISCOPE project: http://episcope.eu/fileadmin/episcope/public/docs/reports/EPISCOPE_Indicators_FirstConcept.pdf).	Supporting	Physical infrastructure	2.4
Improvements to at least thermal protection double glazing	%	This indicator will reflect the share of the number of the buildings with improvements to at least thermal protection double glazing. (As defined in EPISCOPE project: http://episcope.eu/fileadmin/episcope/public/docs/reports/EPISCOPE_Indicators_FirstConcept.pdf).	Supporting	Physical infrastructure	2.4
Roof insulation improved from the original state	%	This indicator will reflect the share of the number of the buildings with an roof insulation inpoved from oridinal state. (As defined in EPISCOPE project: http://episcope.eu/fileadmin/episcope/public/docs/reports/EPISCOPE_Indicators_FirstConcept.pdf).	Supporting	Physical infrastructure	2.4
Population living in a dwelling with leaking roof or damp walls, etc.	% of households	percentage of households living in a dwelling either with a leaking roof or damp walls/ floors/ foundation.	Consensual-based	Physical infrastructure	2.7
Percentage of dwellings built before the thermal regulation	%	Indicator to be built based on the year national regulation war put in place. And the data on building stock age or construction year.	Supporting	Policy-based	2.0
Ability of consumers to switch tariffs	yes/no	The maximum frequency of switching the tariff and average duration of the switching is key. The new tariff should be better for the customer than the old one.	Supporting	Policy-based	2.8
Existence of the market regulation of the rental housing	yes/no	There is a regulated price for housing by building type. The regulated price aims to the specific social groups of tenants. This indicator describes the existence of the market regulation in the rental housing including its future expected development (e.g. year when the regulation will be/was terminated) and provides a short description of the target group.	Supporting	Policy-based	2.6
Dwellings with voluntary certification schemes.	No of	This indicator will reflect the number of buildings/building units with a voluntary certification scheme: Passive House, Minergie, LEED, BREEAM, DGNB, HQE and others	Supporting	Policy-based	2.3
Date of market liberalisation	Year	Number of years since market liberalisation (electricity and gas) available in ACER report 2013 table 29	Supporting	Policy-based	2.6
communal agreements on heating levels	Qualitative		Supporting	Policy-based	2.0
system governance	Qualitative	E.g. privately owned or not	Supporting	Policy-based	1.9
households helped through Warm Front, England	Pounds and	Expenditure and number of households helped through Warm Front, England	Other energy	Policy-based	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
	Absolute number		poverty metric		
Successful claims for National Fuel Scheme payments	number	Social aid for households in energy poverty	Other energy poverty metric	Policy-based	2.4
Winter fuel payments	Pounds &number	The Winter Fuel Payments started in 1997/98 and are payable to all eligible individuals who have reached state pension age for women. Annual number of payments and total expenditure on Winter Fuel Payments	Other energy poverty metric	Policy-based	2.6
Cold weather payment	Pounds & number	Total Expenditure and annual number of payments on Cold Weather Payments. The Cold Weather Payment season runs from 1st November to 31st March. The temperature data used for this indicator relates to the average winter temperature during the months of December to March, and is consistent with the temperature data used in the indicator on excess winter deaths.	Other energy poverty metric	Policy-based	2.6
Households that apply for the right of the status of vulnerable gas/electricity consumer	number	To transfer the cost of necessary supply to the System Operator (postponed payment). Energy Law 17/14, Ordinance on Gas Market (95/07), and Conditions for the supply and consumption of electricity from the electricity distribution network (126/07). Vulnerable consumer is a household customer, which due to its financial circumstances, income and other social circumstances and living conditions cannot obtain an alternative source of energy for heating, which could result in the same or lower costs for residential space heating	Other energy poverty metric	Policy-based	2.4
number of customers that has acquired the status of vulnerable customer	number	HR: Energy Act: a household in which members have been declared by social welfare authorities as socially vulnerable and have a certain degree of disability or have special needs or have degraded health, where curtailment or disconnection may lead to endangerment of life or health (not yet available because the criteria for attaining the status of vulnerable energy costumer are not yet determined). LT: List of socially vulnerable consumers protected from disconnection (Law of Electricity)	Other energy poverty metric	Policy-based	2.1
recognition of energy poverty in government documents	y/n	recognition of energy poverty in government documents (strategy docs, legislation)	Supporting	Policy-based	2.1
number of applicants/beneficiaries of EE scheme for low-income households	number	Energy efficiency measures for households that face the problem of energy poverty. The measures will be aimed at investments as well as advice and action to change energy consumption behavior.	Other energy poverty metric	Policy-based	2.1
number of beneficiaries of social aid	number	It is assumed that the minimum number of energy vulnerable consumer amounts to the number of beneficiaries of social allowance (family and single)	Supporting	Policy-based	2.2
population that receives subsidies for heating and hot water supply services	%	For district heating (Law on Cash Social Assistance for Poor Residents) based on the evaluation of received income and owned property, permanent residents only	Other energy poverty metric	Policy-based	2.6
amount of bill support for heating and hot water for recipients of social benefits	EUR	Amount of bill support provided for heating and hot water supply services via municipalities for recipients of social benefits. For district heating (Law on Cash Social Assistance for Poor Residents) based on the evaluation of received income and owned property, permanent residents only	Other energy poverty metric	Policy-based	2.6

Indicator name	Unit	Definition, description & purpose	Approach	Category	Score [1-3]
number of households that require support to pay energy bills	number	number of households that requires social support to pay its energy bills	Other energy poverty metric	Policy-based	2.4
financial aid during the cold season for vulnerable customers	EUR	% of district heating bill, fixed amount for the gas (heating) bill. Emergency Ordinance no. 70/31	Supporting	Policy-based	1.9
number of beneficiaries of permanent / temporary financial social assistance	number	Financial social assistance is designed to meet the minimum living needs, including energy. When household is a beneficiary of financial social assistance it is automatically considered as a vulnerable consumer. It is assumed that the real minimum number of potential energy vulnerable consumer amounts to at least the number of beneficiaries of financial social assistance.	Supporting	Policy-based	2.0
number of households that receive material need support	number	The households that receives the material need (social allowance) are foreseen to have a risk of energy poverty	Supporting	Policy-based	2.0

Annex B: Secondary EPOV Energy Poverty Indicators

Type	Indicator	Description*	Source
Energy prices:	Fuel oil prices	Average household prices per kWh generated from fuel oil	BSO
	Biomass prices	Average household prices per kWh generated from biomass	BSO
	Coal prices	Average household prices per kWh generated from coal	BSO
	Household electricity prices	Electricity prices for household consumers, band DC 2500-5000 kWh/yr consumption, all taxes and levies included	ESTAT
	District heating prices	Average household prices per kWh from district heating	BSO
	Household gas prices	Natural gas prices for household consumers, band 20-200GJ consumption, all taxes and levies included	ESTAT
Consensual-based	Dwelling comfortably cool in summer time	Share of population, based on question "Is the cooling system efficient enough to keep the dwelling cool?" and/or "Is the dwelling sufficiently insulated against the warm?"	SILC ad-hoc modules 2007 and 2012
	Dwelling comfortably warm in winter time	Share of population, based on question "Is the heating system efficient enough to keep the dwelling warm?" and "Is the dwelling sufficiently insulated against the cold?"	SILC ad-hoc modules 2007 and 2012
	Presence of leak, damp, rot	Share of population with leak, damp or rot in their dwelling, based on question "Do you have any of the following problems with your dwelling / accommodation? • a leaking roof • damp walls/floors/foundation • rot in window frames or floor	SILC
Expenditure-based	Share of energy expenditure in income by income quintile	Consumption expenditure for electricity, gas and other fuels as a share of income for income quintile 1-5	HBS
Building stock features	Dwellings with energy label A	Share of dwellings with an energy label A	BSO
	Dwellings in intermediately populated areas	Share of dwellings located in intermediately populated areas (between 100 and 499 inhabitants/km^2)	BSO
	Dwellings in densely populated areas	Share of dwellings located in densely populated areas (at least 500 inhabitants/km^2)	BSO
	Equipped with heating	Share of population living in a dwelling equipped with heating facilities	SILC, ad-hoc modules 2007 and 2012
	Equipped with air conditioning	Share of population living in a dwelling equipped with air conditioning facilities	SILC, ad-hoc modules 2007 and 2012
	Number of rooms per person by ownership status (renters, owners) and total	Average number of rooms per person in rented/owned/all dwellings	SILC
Poverty and health risks	Poverty risk (AROPE)	People at risk of poverty or social exclusion (% of population)	SILC
	Excess winter mortality/deaths	Share of excess winter mortality/deaths	BSO